Title
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Publication Date
2016-08-10

Research Report – UCD-ITS-RR-16-05

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July 2016

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NEW CAR BUYERS’ VALUATION OF ZERO-EMISSION VEHICLES: CALIFORNIA

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In partial fulfillment of ARB Agreement 12-332

10 August 2016

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Version Note

This is an edited version of the final report submitted to the California Air Resources Board. Edits were made for clarity and consistency. Some figures have been re-formatted. No new data or substantive results are presented here; no data or result in the version available from the California Air Resources Board has been omitted here. The version submitted to the California Air Resources Board is available at: http://www.arb.ca.gov/research/apr/past/12-332.pdf

ACKNOWLEDGMENT

We’d like to thank the households who participated in the research reported here. We’d like to thank Jamie Davies for his work during the household interviews, Tom Turrentine for managing the initial analysis of the interview data, Matt Favetti for programming the on-line survey, and Dr. Gil Tal for managing survey programming.

This Report was submitted in fulfillment of ARB Agreement No. 12-332, New Car Buyers’ Valuation Toward Zero-Emission Vehicles, by the University of California under partial sponsorship of the California Air Resources Board. Work was completed as of 31 March 2016.

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GLOSSARY OF TERMS

Acronym (If any)	Term	Definition
ICE	Internal combustion engine	An engine that burns a fuel in a confined space to produce power. Relevant fuels for this report include gasoline and diesel.
ICEV	Internal combustion engine vehicle	A vehicle powered by an ICE
HEV	Hybrid electric vehicle	A vehicle powered by both an ICE and an electric motor. Energy for the electric motor is stored in a battery that is charged solely by the ICE or the recovery of kinetic energy during coasting and braking. In the course of normal vehicle operation, the battery is not and cannot be charged by plugging it into the electrical grid.
PHEV	Plug-in hybrid electric vehicle	A vehicle powered by both an ICE and an electric motor. Compared to HEVs, PHEVs typically have a more powerful electric motor and a larger battery that in the course of normal vehicle operation can be plugged into the electrical grid to charge.
	Charge depleting operation	That portion of driving done in a PHEV that consumes energy from its battery until a design minimum state of battery charge is reached. At that time, the vehicle switches to charge sustaining operation (see definition below).
	All-electric charge depleting operation	A PHEV design in which only electricity is used to power the car during charge-depleting operation. In effect, such PHEVs are capable of operating as a BEV and as an ICEV.
	Assist charge depleting operation	In contrast to an all-electric charge depleting design, a PHEV with an assist charge depleting design may use the ICE to power the vehicle regardless of the state of charge of the battery.
	Charge sustaining operation	The operating principle for all PHEVs after their batteries reach their design minimum state of charge: the battery is “sustained” at or near its minimum state of charge until the battery is recharged by plugging into the grid. The vehicle operates as an HEV (see description above).
BEV	Battery electric vehicle	A vehicle powered solely by an electric motor and electricity stored in a battery that must be charged

		by plugging it into the electrical grid.
PEVs	Plug-in vehicles	An overall category for all vehicles with batteries that are charged by plugging into the electrical grid, i.e., BEVs and PHEVs.
FCEV	Fuel cell electric vehicle	A vehicle powered solely by an electric motor and electricity produced onboard the vehicle by a fuel cell. To produce electricity, the fuel cell requires oxygen and hydrogen. Oxygen is taken from the atmosphere. Hydrogen must be refueled much as an ICEV is refueled.
ZEV	Zero emission vehicle	A regulatory definition denoting vehicles producing no on-road emissions. BEVs and FCEVs are ZEVs.
CARB	California Air Resources Board	
NESCAUM	Northeast States for Coordinated Air Use Management	A non-profit organization providing a forum for discussion, research, and support to its member states on a variety of environmental issues.

ABSTRACT

New car buyers' awareness, knowledge, experience, consideration, and valuation of plug-in hybrid electric vehicles (PHEVs), battery electric vehicles (BEVs), and fuel cell electric vehicles (FCEVs) as well as respondents' attitudes toward the public policy goals of vehicles were assessed via an on-line survey and in-person interviews with a subset of the survey respondents. Questions about awareness, knowledge, experience, and consideration were asked prior to the valuation measure—the drivetrain type of a plausible next new vehicle designed by each respondent. The survey was administered in California, Oregon, Washington, Delaware, Maryland, New Jersey, New York, Massachusetts, and the other member states of the Northeast States for Coordinated Air Use Management (NESCAUM). Interviews were conducted in California, Oregon, and Washington. This report focuses on the results for California, though these are compared to results from other states. Even in California, prior awareness, knowledge, experience and consideration of PHEVs, BEVs, and FCEVs were low. Still, 38% of CA respondents—representing nearly 1.5 million new car-buying households—designed a PHEV (21%), BEV (11%), or FCEV (6%) in a "design world" that does not allow battery-powered all-electric drive in full-size vehicles but does offer incentives modeled on those available at the time of the survey. Respondent clusters are identified by motivations for or against designing a PHEV, BEV, or FCEV. The overarching conclusion is the first barrier to achieving emissions and energy goals of zero-emission vehicles (ZEVs) is few new car-buying households in California have yet to ask themselves whether and how they value ZEVs.

EXECUTIVE SUMMARY

Objectives and Methods

This study has three objectives:

1. Measure new car buyers' awareness, knowledge, experience, consideration, and valuation of plug-in hybrid electric vehicles (PHEVs), battery electric vehicles (BEVs), and fuel cell electric vehicles (FCEVs);
2. Describe new car buyers' decision making regarding prospective PHEV, BEV, and FCEV purchase decisions; and,
3. Compare new car buyers in California and other states with zero emission vehicle (ZEV) requirements or sales.

To accomplish these objectives an on-line survey of new car buying households and follow-up interviews with a subset of survey respondents were conducted. The survey was administered to samples of new car-buying households from mid-December 2014 to early January 2015. The survey was administered in thirteen states: California, Oregon, Washington, Delaware, Maryland, New Jersey, New York, Massachusetts, Connecticut, Rhode Island, New Hampshire, Vermont, and Maine. The final eight states in this list are the member states of the Northeast States for Coordinated Air Use Management (NESCAUM). Follow-up interviews with subsets of survey respondents were conducted in California, Oregon, and Washington from January to March 2015.

Survey data were analyzed both to describe the sample and to model ZEV valuation. The primary measure of ZEV valuation is the drivetrain of a vehicle each respondent designs as a plausible next new vehicle for his or her household. The five categories of vehicle-drivetrain types were internal combustion engine (ICEV), hybrid electric (HEV), PHEV, BEV, and FCEV. A nominal logistic regression model estimated the probability a respondent designed a vehicle of each drivetrain type. The substantive meaning of the model is derived from which explanatory variables are included. The model shifts the results from merely describing respondents' vehicle designs to understanding why different respondents design different vehicles. Four categories of explanatory variables were tested: 1) respondent socio-economic and demographic measures, 2) prior vehicle purchase, ownership, and travel, 3) prior awareness and assessments of ZEVs, ZEV policy instruments, and technology, and 4) attitudes toward ZEV policy goals and tools. The logistic regression model describes correlations of drivetrain types with these four categories of variables. Further, following the vehicle design games respondents scored a set of motivations for ZEVs (if they designed a PHEV, BEV, or FCEV) or against (if they designed an ICEV or HEV). This exercise furthers the discussion of why respondents design different vehicles. Analysis of post-vehicle design motivations examines respondent's own commentary on why they designed a particular type of vehicle. Further, clusters of respondents of who share similar motivations for or against ZEVs are identified to aid education, outreach, and marketing.

Interviews with survey respondents enhance the shift from description to explanation by allowing extended conversation, reflection by respondents, and commentary in their own words. Interviews were conducted with a sample of households stratified by whether or not they designed a PHEV, BEV, or FCV and whether or not at any point in the multiple design games they designed a vehicle of a body style and size that is not anticipated to be offered with battery-powered, all-electric drive, i.e., full-size vehicles. Interviews were semi-structured: while there was an outline of desired topics and suggested questions, the interviewees were free to take the conversation where they wished. The interviewers assured all topics were covered. Interview data in the form of notes and audio-recordings were analyzed to identify themes in a three step process: 1) open coding during a first reading to identify possible themes and assign initial codes; 2) axial coding reviews and revises initial themes based on multiple comparative readings; and, 3) selective coding identifies examples to illustrate themes.

Results

California new car buyers' awareness, knowledge, experience, consideration, and valuation of PHEVs, BEVs, and FCEVs

Even in California, new car-buyers' valuations of ZEVs are largely unformed. Despite marketing PEVs and deploying PEV charging infrastructure since 2010 as well as federal, state, and local incentives for PEV purchase and use, 77% of respondents representing new car-buying households in California have yet to seriously consider a PHEV or BEV for their household; 92% have yet to ask themselves the same question about FCEVs. More than five years after PEV marketing started in California two-thirds of respondents—who as new car buyers have searched for information about cars, been on new car lots, and purchased a vehicle during this period—can't name a BEV presently for sale in the US. Of those in California who can name a BEV presently for sale, 95% name one of only two vehicles; name recognition has not spread beyond the earliest entry vehicles. The conclusion that by-and-large California new car-buyers have yet to even consider ZEVs is further reinforced by the interviews in California (as well as Oregon and Washington) in which it was clear most respondents had formulated their first ZEV valuation in the process of completing their survey and interview. Overall, this means that how and how much consumers will value ZEVs is still subject to new information and experience.

Within this overall context of generally low levels of awareness of, and almost no experience with, PHEVs, BEVs, and FCEVs, *38% of the CA sample had a sufficiently positive valuation to design a PHEV (21%), BEV (11%), or FCEV (6%) as their next new vehicle. Expanded to a population level estimate, this is the equivalent of nearly 1.5 million households.* Households who have the infrastructure to charge or fuel at home are more likely to design a PHEV, BEV or FCEV. Households with higher familiarity with all drivetrain types and greater experience driving HEVs, PHEVs, BEVs, or FCEVs are more likely to have a higher ZEV valuation. Households with more favorable assessments of the comparative safety and reliability of PEVs compared to ICEVs and households with more favorable assessments of the driving range per charge/fueling and charging and fueling times of PEVs and FCEVs are more likely to design such vehicles. Households who are more concerned that air pollution is both a regional threat and a personal risk are more likely to design PEVs and FCEVs. Households who have already considered PEVs or FCEVs—to the extent they have searched for information, visited a vehicle dealership, or may drive one already—have higher valuations of ZEVs. Controlling for all these associations, whether a household believes they have heard of federal or California incentives is not related to their ZEV valuation, but whether the respondent believes governments should offer such incentives is. (The questions were not specific to the present federal tax credit for PEVs or California's Clean Vehicle Rebate Program. Respondents were asked if they had heard there are incentives for "alternatives to gasoline and diesel.") This question of incentives and other results pertaining to electricity vs. hydrogen indicate there may be a divide between those who favor BEVs and those who favor FCEVs. Holding all other variables constant, higher probabilities of designing a BEV and lower probabilities of designing an FCV (and vice versa) are estimated when the respondent believes that only electricity (or only hydrogen) should be incentivized.

The results listed in the previous paragraph may be summarized as follows. When measures specific to ZEVs, ZEV "fuels" (electricity and hydrogen), and ZEV policy goals are considered, then more general socio-economic and demographic descriptors of people and measures of their vehicle holdings, travel, and residences tend not to be correlated with respondents' drivetrain designs in the survey.

Post-design game motivations for and against designing PHEVs, BEVs, and FCEVs

Addressing the approximately one-third of the sample that designs a PHEV, BEV, or FCEV, cluster analysis searches for clusters of these respondents who share motivations. The results reinforce some conclusions of the statistical modeling and offer some new insights. The following describes a four-cluster solution:

- *Pro-social technologists* have high average scores for all pro-social motivations: climate change, energy supply and security, and air quality. Three other motivations also have high average scores, but don't form a single meaning: interest in ZEV technology, convenience of home charging, and save fuel costs. In naming this cluster, we chose to emphasize technology because "I'm interested in the new technology" is scored highly and that new technology enables a valued new behavior, i.e., home charging, and is the source of the fuel costs savings through the substitution of electricity for gasoline.
- *Thrifty environmentalists* are the only cluster to give high average scores to all the cost motivations highly, including incentives. What distinguishes thrifty environmentalists from pro-social technologies is the relative balance of the strength of private cost vs. pro-social motivations.
- *Private hedonists* score no pro-social motivation highly; their high mean motivation scores are given for private desires: fun, comfortable, safe, good looking cars that make the right impression on family and friends, and fuel cost savings.
- A fourth cluster tends to score only one or two motivations highly. Many of these respondents pick one of the motivations that all three of the other clusters share— interest in new technology or fuel cost savings.

Seven motivations are highly scored by more than one cluster: interest in ZEV technology, convenience of home charging, fuel cost savings, climate change, reducing payments to oil producers, and air quality. These suggest messages and media for crosscutting social networks to support market development—even "private hedonists" and "pro-social technologists" share the motivations of interest in ZEV technology and fuel cost savings.

The assessment of the motivations of those who don't design a PEV or FCEV indicates most of these respondents have litanies of questions and concerns, only a few of which are addressed by present incentives. As 62% of respondents don't design a PEV or FCEV as their next new vehicle, understanding their motivations helps define actions required to remove barriers. As indicated earlier the primary barrier for many seems to be that ZEVs are simply unknown. In contrast to the cluster analysis for those who did design PEVs and FCEVs, the cluster analysis of the motivations of those who did not is more singular in its conclusion. A three-cluster solution includes two clusters characterized as “worried about a lot” because their mean scores for half or more of all motivations to not design a ZEV score are higher than the global mean for all respondents and all motivations. By contrast, the third cluster registers only barely above average concern with “vehicle purchase price and “unfamiliar technology.” Vehicle purchase price and unfamiliar ZEV technology are the only motivations scored higher than the mean by all three clusters. In contrast, none of the three clusters highly scored the item “higher incentives would have tempted me.”

Comparative States Analysis

The discussion here focuses on comparisons between California, Oregon, Washington, Delaware, Maryland, and the aggregate of the NESCAUM-member states. As in the previous discussion of the California results, the discussion moves from prior consideration to the drivetrain designs created by respondents to a summary of the mathematical models of those designs.

Levels of prior consideration of PEVs and FCEVs, that is, whether respondents had already considered a PEV or FCEV for their household prior to completing the on-line survey, are low among new car buyers across all the study states and the NESCAUM region. Still, respondents are more likely to have given higher levels of prior consideration to PEVs and FCEVs in California, Oregon, and Washington than in the NESCAUM region, Maryland and Delaware. Further, some degree of actual resistance to the idea of PEVs and FCEVs is more common in the eastern states and region than in the western states. Prior consideration is higher for PEVs than FCEVs everywhere, as one might expect given the tiny number of FCEVs that have been leased and the strictly proscribed regions in which those leases are available at present. A statistical test confirms the differences between the states and NESCAUM region are significant ($\alpha < 0.05$): Oregon and California have the highest percentages of respondents at the highest levels of prior consideration.

In every state and the NESCAUM region, fewer respondents design a next new vehicle for their household to be a PHEV, BEV, or FCEV than do so. Still, between one-fourth (NESCAUM) and two-fifths (Oregon and California) of new car buyers are ready to consider a PEV or FCEV for their household. The differences between states—and in particular between western and eastern states—is more pronounced than the differences in prior consideration. A statistical test confirms the differences between the states and NESCAUM region are significant ($\alpha < 0.05$).

The results of statistical modeling for eight states (California, Oregon, Washington, Maryland, Delaware, New Jersey, New York, and Massachusetts) plus a ninth model for the NESCAUM region were reviewed for which explanatory variables were correlated to respondent drivetrain designs across multiple state and regional contexts and which were limited to one or a few. Almost no measures of socio-economics, demographics and political affiliations appear in any model of respondents’ drivetrain designs given the other variables that do appear in the models. Of all the contextual measures of household vehicles, daily travel, and residences only those that pertain to whether respondents are likely to be able to charge a PEV at home appear in several models. Broad support for ZEV policy goals is expressed only for air quality, not climate change or energy supply and security.

The conceptual group of potential explanatory variables that provides the most separate measures to the greatest number of state and regional models of respondents' PEV and FCEV valuations is the one containing measures specific to PEVs, FCEVs, electricity, and hydrogen. These include:

- Belief that electricity or hydrogen are likely replacements for gasoline and diesel fuel;
- Personal interest in ZEV technology;
- Familiarity with all vehicle drivetrain types included in the design games: ICEVs, HEVs, PHEVs, EVs, and FCEVs;
- Prior assessments of EVs and FCEVs on six dimensions including charging/fueling, purchase price, safety, and reliability;
- Experience driving vehicles of the different drivetrain types;
- Whether respondents have already seen PEV charging in the parking facilities they use
- Extent to which respondents have already considered acquiring a PEV or FCEV.

Post-design game motivations for and against designing PHEVs, BEVs, and FCEVs

Analyses of post-game motivations were performed for the other participating states. The comparison here is between California respondents and the aggregate of all the other respondents. Though there is no specific statistical test, the figures illustrate that at least for three of the four clusters identified for California, it is possible to match at least three of four clusters created from the respondents in all other states to three clusters of California respondents: "Private Hedonists, "Pro-social technologists" and "Why did they design a PEV or FCEV?"

The one California cluster for which a match from the data for all other states appears not to be appropriate is for the Thrifty environmentalists." More than any cluster from California and more than the other clusters from the aggregate of all states, the fourth cluster of PHEV, BEV, and FCEV designers from all the other states is something of a "generalist" cluster, with above average mean motivation scores in all the categories of motivations: ZEV technology, general vehicle attributes, a variety of costs, aesthetics and lifestyle, and pro-social goals.

The motivations of those who don't design a PHEV, BEV, or FCEV were also compared between the California sample and the aggregate of all other states. Clusters of motivations appear similar between the two samples. In both samples there are two clusters with litanies of highly scored reasons why they did not design a PHEV, BEC, or FCEV and there is one cluster for which the analysis discerns no strong reason other than they are unfamiliar with ZEV technology.

Elaborating on the Pros and Cons of ZEVs: Interviews of Survey Respondents

The post-survey interviews elaborate on respondent awareness, knowledge, consideration, and valuation of ZEVs. The results are presented in five themes. The themes are products of the analysis of the interviews; they are not necessarily subject headings in the interview guide:

1. Respondents who can imagine owning a ZEV (or ZEV-enabling vehicle),
2. Those who cannot imagine owning a ZEV,
3. The lure and lore of Tesla,
4. Frequently asked questions (FAQs), and
5. The future of cars.

In general, the interviews reinforce the conclusion that most survey respondents were creating their valuation of ZEVs for the first time when they completed the survey for this study. From the interviews, these valuations can be more subtly sorted into whether positive valuations ("I can imagine life with a ZEV) were more or less likely to be turned into near- or long-term decisions to buy a ZEV. The second ("I can't imagine life with a ZEV") and fourth (FAQs) thematic areas emphasize lack of awareness, experience, and knowledge (or presence of misinformation or misimpressions). Discussions in these areas often started with one question—or even an imagined solution—then quickly snowballed into a litany of concerns. As an example, one interview participant turned imagined large increases in BEV driving range into a new set of problems:

> "Let's say somehow, somebody comes up with a great new battery that holds a charge for 400 miles. Well that's fine but then if when I plug it in is it going to take 48 hours to recharge it? And then also how much electricity is that going to take? Is it suddenly going to double my electricity consumption because I'm plugging in my car every night, you know that's a big deal. And then it becomes how much does that cost. Not necessarily in a financial way but also in convenience and time."

These sorts of instabilities—in which a solution to one problem begets new imagined problems and lists of questions—and the apparent confusion about the distinctions between HEVs, PHEVs, and BEVs that become evident in the interviews, align with survey data, e.g., ratings of (lack of) experience with PEVs and FCEVs to support the conclusion that most respondents in the interviews and survey have yet to ask and seriously consider whether a PEV or FCEV is right for their household.

INTRODUCTION

Policy goals for vehicles powered (in part or in whole) by electricity or hydrogen include reduced emissions of criteria pollutants and greenhouse gasses from motor vehicles. Battery electric vehicles (BEVs) powered-solely by electricity and hydrogen fuel cell electric vehicles (FCEVs) are zero-emission vehicles (ZEVs). Plug-in hybrid electric vehicles (PHEVs) are powered by both electricity and gasoline. PHEVs and BEVs are collectively known as plug-in electric vehicles (PEVs). New automotive product offerings and energy industry and utility responses to air quality, climate, energy, and ZEV regulatory frameworks mean consumers are confronted with new vehicle technologies and asked to consider new driving and fueling behaviors. Even as PHEVs, BEVs, and FCEVs enter the vehicle market, nascent PEV recharging infrastructure is being deployed and hydrogen-fueling infrastructure is being planned and constructed, questions remain as to whether consumers will purchase PEVs and FCEVs.

This research addresses the questions of whether and how households who tend to acquire their vehicles as new value ZEVs in comparison to ICEVs and HEVs.[1] This report presents findings regarding new-car buyers' valuations of ZEVs and ZEV-enabling technologies as measured by their intentions toward these technologies, describes why people hold these intentions, and characterizes the antecedents to these intentions. Our research seeks to answer the question of how consumers respond to new technology vehicles and new fueling behaviors. Answering these questions was accomplished by measuring consumer awareness, knowledge, engagement, motivations (pro and con), and intentions regarding PEVs and FCEVs.

This study has three objectives:

1. Measure new car buyers' awareness, knowledge, experience, consideration, and valuation of plug-in hybrid electric vehicles (PHEVs), battery electric vehicles (BEVs), and fuel cell electric vehicles (FCEVs);
2. Describe new car buyers' decision making regarding prospective PHEV, BEV, and FCEV purchase decisions; and,
3. Compare new car buyers in California and other states with zero emission vehicle (ZEV) requirements.

A multi-method research agenda was used to gather data in thirteen states: California, Oregon, Washington, Oregon, Delaware, Maryland, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and Maine. The survey measured the distribution of consumer knowledge and beliefs about conventional vehicles powered by internal combustion engines (ICEVs), hybrid vehicles (HEVs), PEVs, and FCEVs. Interviews with a subset of survey respondents in California, Oregon, and Washington elaborated on consumer awareness and knowledge of, as well as motivation and intention toward, PEVs and FCEVs. Results include an enumeration of the present responses of new car buyers to the new technologies as well as an

[1] This focus on households who acquire new vehicles is not a requirement or assumption about who will acquire PEVs and FCEVs in the near future. The requirement that households have purchased a new vehicle within seven model years prior to the survey date assures they had shopped for a vehicle during the period PEVs started to appear in the market and that the respondents' households do buy new (possibly in addition to used) vehicles. Further, PEVs were just starting to appear in small numbers in the used vehicle market at the time of this study.

understanding of what can be done to transform the positive intentions towards ZEVs into purchases and the negative intentions toward ZEVs into positive ones.

Regarding the comparative discussion later in the report, the study was conducted as a joint set of state studies. With the exception of California, the Northeast States for Coordinated Air Use Management (NESCAUM) coordinated the participation of all other states. NESCAUM additionally supplied funding for sampling in NESCAUM-member states who did not participate in the study, i.e., Connecticut, Maine, New Hampshire, Rhode Island, and Vermont. This allows for a NESCAUM-wide analysis when these data are combined with those NESCAUM-member states who made the commitment to maximize their state sample so as to produce the best possible estimates for their state: Massachusetts, New Jersey, and New York.[2] Thus comparisons will be made to these three states, the NESCAUM region, as well as Oregon, Washington, Delaware, and Maryland.

Background

This background summarizes policies, vehicles, incentives and infrastructure efforts of policy makers, vehicle manufacturers, and infrastructure providers to establish a consumer market for PEVs and FCEVs in California. This is a brief overview of the ZEV context of which consumers could be aware and in which they could be participating.

Federal Tax Credit

A buyer of any qualifying PEV anywhere in the country is eligible for a federal tax credit. The federal tax credit is $7,500 for all BEVs presently for sale in the US. The credit for PHEVs ranges from $2,500 to $7,500 depending on the size of the traction battery.

A Multistate ZEV Policy Framework

In an attempt to improve local air quality and reduce the emissions that contribute to climate change, California adopted a zero emission vehicle (ZEV) mandate requiring manufacturers of passenger cars and light trucks to sell a certain percentage of ZEVs. Beginning in 1990 the requirements of the ZEV regulation were that in 1998 two percent of light-duty vehicles for sale in California had to be ZEVs, in 2001 it would increase to five percent, and in 2003 it would be ten percent.[3] This requirement has gone through several modifications in the last 25 years. ZEVs are any vehicle that releases zero emissions during on-road operation. They include BEVs and FCEVs. Other vehicle types, such as PHEVs can be considered transitional ZEVs. Other states have since adopted California's current standards, including these states in this study: Oregon, Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Rhode Island and Vermont.

The California Air Resources Board (ARB) determines how many ZEV credits are required to satisfy its mandate each year. Notably, one credit does not equal one vehicle. Presently, a BEV

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[2] Sample sizes for Massachusetts, New Jersey, and New York were the largest possible from the sample vendor; sample sizes for all other NESCAUM states were scaled to the New York sample size by relative population.
[3] http://www.arb.ca.gov/msprog/zevprog/zevregs/zevregs.htm

earns between one and nine ZEV credits depending on driving range. Starting with model year 2018 the credits will be rescaled. In an effort to make compliance easier for automakers, credits may be traded between manufacturers and manufacturers can meet their sales requirements with a mix of vehicle technologies. Within three separate sets of states, automakers are also allowed to apply ZEV credits earned in one state to their ZEV requirements in other states as long as they sell a minimum number of ZEVs in each participating state.

California's goals pertaining to ZEVs include:

1) Reduce GHG emissions from the transportation sector to 80 percent below 1990 levels by 2050 per Executive Order B-16-2012;
2) Reduce GHG emissions to 40 percent below 1990 levels by 2030 per Executive Order B-30-2015;
3) Meet federal health based ambient air quality standards for ozone by 2023 and 2031 in addition to the fine particulate matter (PM2.5) air quality standards. (ARB has estimated that the 2031 ozone standard will require oxides of nitrogen (NO_x) emission reductions of 90 percent compared to 2010 levels.);
4) Deploy 1.5 million ZEVs by 2025 in order to meet the Governor's goal as directed in Executive Order B-16-2012 and the related goal of deploying 1 millions ZEVs and near-zero emission vehicles by 2023 as codified in Health and Safety Code Section 44258.4(b);
5) Reduce petroleum use by 50 percent by year 2030 as stated in Governor Brown's 2015 State of the State address;
6) Reduce the carbon intensity of California's transportation fuels by 10 percent by 2020 as required by the Low Carbon Fuel Standard (LCFS); and
7) Continue to reduce health risks from toxic air contaminants exposure from diesel particulate matter and others particularly in disadvantaged communities.[4]

California ZEVs

Towards these goals, many PHEVs and BEVs are now or have been available for sale in California.[5] BEVs include the Fiat 500e, Ford Focus BEV, BMW i3, Chevy Spark BEV, Honda Fit BEV, Kia Soul BEV, Mercedes B-Class Electric, Mitsubishi i-Miev, Nissan Leaf, Smart Electric Drive, Tesla Roadster and Model S, Toyota Rav4 BEV and Volkswagen E-Golf. PHEVs include the Cadillac ELR, Chevy Volt, Ford C-Max Energi and Fusion Energi, Honda Accord Plug-in Hybrid, Mercedes-Benz S550e Plug-in Hybrid and the Toyota Prius Plug-in Hybrid. As of June 2015, 49% of the ZEVs sold or leased in California were BEVs and 51% were PHEVs, compared with the national average of 47% BEVs and 53% PHEVs sold or leased.[6] As of August 2014, approximately 40% of all PEVs sold in the U.S. were in California.[7] As of August 2015, California had paid approximately 113,000 Clean Vehicle Rebates (CVR)—most of these

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[4] Proposed_fy15-16_funding_plan.pdf

[5] Vehicles introduced since 2010 but subsequently discontinued are included in the list as they were part of the rollout of PEVs that forms the context to which participants were responding. Vehicles that have been discontinued as of the date of this report include Honda Fit BEV, Tesla Roadster, Toyota RAV4 BEV, and Honda Accord PHEV.

[6] http://energy.gov/eere/vehicles/fact-877-june-15-2015-which-states-have-more-battery-electric-vehicles-plug-hybrids

[7] http://www.energy.ca.gov/transportation/zev/pev/

have been paid for the BEVs and PHEVs listed here. Approximately 100 CVRs had been paid for FCEVs. The retail availability of FCEVs is presently limited to leases on a very small number of Honda FCX Clarity, Hyundai Tucson Fuel Cell, and Toyota Mirai.

California State ZEV Policy and Incentives

California ZEV buyers' eligibility for incentives to buy and drive ZEVs varies from the ubiquitously available federal tax credit appropriate for their vehicle to quite limited eligibility. Limits on eligibility might be location-based, e.g., where the ZEV driver lives, vendor-based, e.g., what insurance company the ZEV driver uses to insure their ZEV, or have some other basis. Examples of these additional incentives include:

1) State HOV Lane Exemption allows ZEV drivers to use designated HOV lanes regardless of the number of occupants in the vehicles, they are also exempt from High Occupancy Toll fees;
2) Alternative Fuel Vehicle Rebate Program offers rebates for the purchase or lease of qualified vehicles via The Clean Vehicle Rebate Project. Current rebates are up to $2,500 for light duty BEVs and PHEVs and $5,000 for FCEVs that the California Air Resources Board has approved or certified;
3) Sales Tax Exclusion for Manufacturers, expires June 30, 2016;
4) Alternative Fuel Vehicle Rebate Program provides a rebate of up to $3000 for the purchase or lease of eligible new vehicles via the Drive Clean! Rebate Program administered by The San Joaquin Valley Air Pollution Control District;
5) Alternative Fuel and Vehicle Incentives for businesses, vehicle and technology manufacturers, workforce training partners, fleet owners, consumers and academic institutions in order to develop and deploy alternative and renewable fuels and advanced transportation technologies via the Alternative and Renewable Fuel Vehicle Technology Program;
6) Insurance Discount up to 10% discount from Farmer's Insurance on certain coverage for HEV and AFV owners;
7) PEV Charging Rate Reductions through The Sacramento Municipal Utility District, Southern California Edison, Pacific Gas & Electric, Los Angeles Department of Water and Power, and San Diego Gas & Electric;
8) Electric Vehicle Supply Equipment Rebate via the Charge Up L.A.! Program administered by The Los Angeles Department of Water and Power, the first 2,000 residential and commercial customers who install a Level 2 240 Volt charger qualify for a rebate. Glendale Water and power offer residential customers owning an electric vehicle and installing a Level 2 charger a rebate of $200;
9) Initially free, now discounted, parking for PEVs in designated downtown Sacramento parking garages and surface lots that are certified by the city's Office of Small Business Development;
10) Free Parking in San Jose, Hermosa Beach, and Santa Monica for those BEVs displaying a Clean Air decal;
11) Alternative Fuel Vehicle Parking in order to incentivize the use of alternative fuel vehicles The California Department of General Services and California Department of Transportation must provide 50 or more parking spaces and park-and-ride lots owned and operated by DOT

California Governor Jerry Brown along with California corporate leaders and the California Plug-In Electric Vehicle Collaborative hosted Drive The Dream (2013 and 2015) to demonstrate to the public PEVs are "popular, affordable, and fun to drive."[8] They showcase corporate investments in workplace charging, the purchase of PEVs in fleets, and employee incentive programs for the purchase of PEVs. One main goal of this program is to get corporate leaders to commit to furthering the growth of PEVs in California by making substantial investments to workplace charging and other incentives. Many California companies offer Level 1 and/or Level 2 charging opportunities to their employees. Google, Apple, NetFlix, Qualcomm, Facebook, and others have already installed hundreds of Level 2 charging stations for their employees to use while at work.[9] Some companies cover the cost of charging while others do not. Sony, along with other companies, is offering buy-down incentives to employees who drive a PEV.[10]

PEV Charging Infrastructure

As of November 2015, California has the largest network of non-residential PEV chargers accessible to the public of any state, totaling over 8,303 outlets at 2,755 locations.[11] California is part of the West Coast Green Highway that aims to install DC fast charging stations every 25-50 miles along Interstate 5, running from the Canadian border to the Mexican border.[12] Other major roadways also offer charging stations within a half-mile of the highway where drivers can patronize coffee shops, restaurants, and shopping centers.

ECOtality launched The EV Project in October 2009 using a $99.8 million dollar grant from the U.S. Department of Energy. In June 2010 it was granted another $15 million by the U.S. Department of Energy and along with partner matches, the total value was approximately $230 million. Partnering with Chevrolet and Nissan, ECOtality provided a Blink wall mount residential charger at no cost plus up to $400 toward installation cost to qualified participants. In exchange, those receiving a charger agreed to allow vehicle and charge data to be collected. The EV Project was "the largest deployment of electric vehicles and charge infrastructure in history"[13] and met their goal for residential charging units in March 2013. California was an important part of The EV Project as it deployed charging infrastructure in San Diego, the San Francisco Bay Area, and Los Angeles.

[8] http://www.pevcollaborative.org/drivethedream2015-about
[9] http://driveclean.ca.gov/pev/Charging/Public_and_Workplace_Charging.php
[10] http://driveclean.ca.gov/pev/Resources_For_Businesses.php
[11] http://www.afdc.energy.gov/fuels/stations_counts.html. Accesses 11 November 2015.
[12] http://www.westcoastgreenhighway.com/electrichighways.htm
[13] http://www.theevproject.com/overview.php

METHODS

Data Collection

The overall study design included an on-line survey (administered in all study states) and follow-up interviews with a subset of survey respondents in California, Oregon, and Washington. A single questionnaire was designed and implemented for all participating states. This foreclosed customization to the specific circumstances in each state, e.g., whether and which ZEVs are for sale, state and local policies to support ZEVs. The on-line survey was conducted from December 2014 to January 2015 and the follow-up interviews in January, February, and March 2015. Interview households were drawn from those who indicated strong positive purchase intentions for ZEVs as well as from households who indicated no or negative interest toward ZEVs.

The online survey is best suited to questions of "how many?" The interviews are best suited to answer questions of "why?" The survey provides a snapshot of what the population looks like at the time the survey is completed. The interviews position each respondent's answers to their questionnaire within a longer-term perspective—both into their past and prospecting their future. In the questionnaire the respondents expressed what they know about ZEVs and whether they have a positive or negative valuation of such vehicles. The interviews explore how they came to their state of knowledge and valuation.

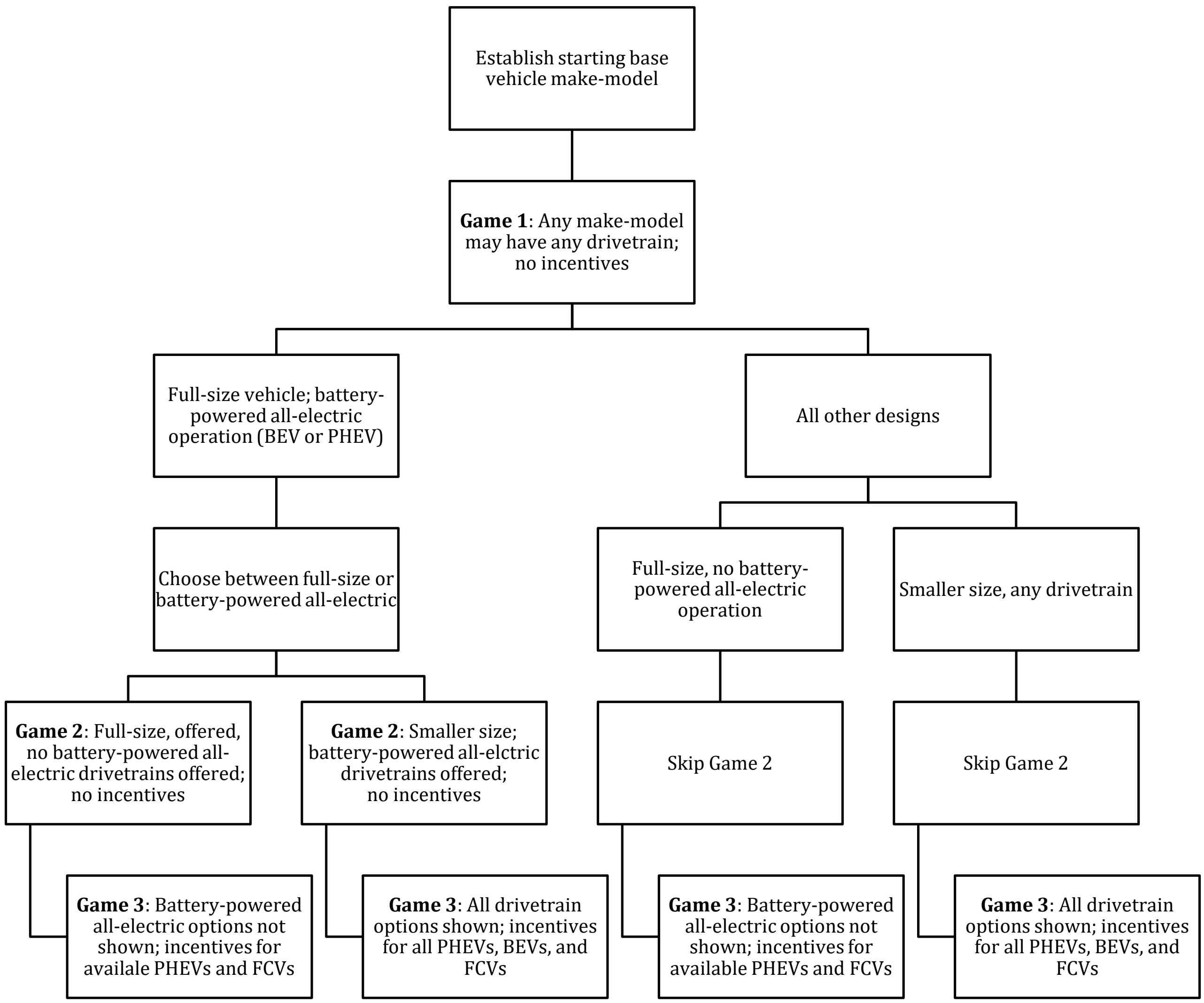
Online Survey Instrument Design

The online questionnaire was divided into six main sections. The first assessed vehicle ownership, vehicle fuel types, and estimated monthly driving distances and fueling costs. The second assessed attributes of daily driving such as use of HOV lanes and toll facilities, commuting, flexibility within household to reassign vehicles and home parking conditions including access to both parking and power (electricity and natural gas). The third queried respondents about their prior awareness, knowledge, and consideration of vehicles powered—in part or in whole—by electricity or hydrogen. The fourth section was the primary measure of respondents' valuation of PHEVs, BEVs, and FCEVs; it is described in detail in the following section. The fifth section asks for respondents to provide an after-the-fact description of their motivations for their vehicle designs in the fourth section. The sixth section measures additional attitudes toward the policy goals behind vehicle electrification, e.g., air quality, climate change, and fuel flexibility and security, attitudes toward new technology, ZEV technology, household socio-economic and demographic descriptors and political beliefs and affiliations. An annotated copy of the on-line questionnaire is provided in Appendix F.

Primary assessment of respondents valuation of PHEVs, BEVs, and FCEVs

ZEV valuation was assessed via vehicle design games in which respondents designed a plausible next new vehicle for their households. These games were administered to the large sample survey and reviewed with the subset of households that participated in follow-up interviews. Researchers from the Center have used such games to previously assess new car buyer valuation in natural gas ICEVs, HEVs, PHEVs, and BEVs. A series of two to three vehicle design games was customized to each participant. Depending on their vehicle designs, respondents designed two or three vehicles as vehicle body styles/sizes allowed to have all-electric drive were restricted and ZEV incentives were added. The possible paths through the design games are illustrated in Figure 1.

Figure 1: Possible Respondent Paths through the Design Games



The design games are constructive—people assemble a vehicle they would want for their household's next new vehicle. Participants were first asked to the extent they have considered their next new vehicle what that vehicle is likely to be. Given this starting vehicle, respondents manipulate: 1) drivetrain type (ICEV, HEV, PHEV, BEV, or FCEV), and for PHEVs, BEVs, and FCEVs 2) driving range per refueling and/or recharging, 3) home vs. non-home recharging and refueling, 4) and time to recharge or refuel. Their base vehicle's manufacturer's suggested retail price (MSRP) establishes their base purchase price in the design games. Any drivetrain other than an ICE incurs incrementally higher prices as shown in Table 1 for four body style and size categories. Each respondent sees incremental prices only for the body style and size corresponding to their base vehicle. These prices are added to the MSRP of each respondent's base vehicle in the first design game. The MSRP and any incremental price are shown to respondents as separate line items in the total price section at the bottom of each design page.

Table 1: Incremental price to redesign ICEVs as HEVs, PHEVs, BEVs, and FCEVs[1]

	Body Style and Size Categories			
Drivetrain type-range (miles)	Sub-compact and Compact Cars	Mid-size car, Large car, or Small SUV	Mid-size SUV, Minivan, Small pickup truck	Full-size van, Large pickup truck, Large SUV
HEV	$1,620	$1,890	$2,400	$3,020
Assist PHEV-10[2]	$2,420	$2,770	$3,400	$4,270
Assist PHEV-20[2]	$2,860	$3,280	$4,090	$5,080
Assist PHEV-40[2]	$3,740	$4,310	$5,460	$6,700
Assist PHEV-80[2]	$6,380	$7,420	$9,550	$11,560
All- Electric PHEV-10[2]	$5,070	$6,260	$8,370	$11,410
All-Electric PHEV-20[2]	$6,040	$7,390	$9,880	$13,190
All-Electric PHEV-40[2]	$7,980	$9,640	$12,900	$16,750
All-Electric PHEV-80[2]	$13,800	$16,370	$21,960	$27,430
BEV-50	$7,630	$9,130	$12,260	$15,540
BEV-75	$10,055	$11,945	$16,040	$19,990
BEV-100	$12,480	$14,760	$19,820	$24,440
BEV-125	$14,905	$17,570	$23,595	$28,885
BEV-150	$17,330	$20,380	$27,370	$33,330
BEV-200	$22,180	$26,010	$34,930	$42,230
BEV-300	$27,030	$31,630	$42,480	$51,120
FCEV-150	$22,180	$26,010	$34,930	$42,230
FCEV-250	$24,180	$28,010	$36,930	$44,230
FCEV-350	$28,180	$32,010	$40,930	$48,230

1. These incremental prices are added to the MSRP if the respondent's base vehicle is a conventional ICEV. If their base vehicle is an HEV, PHEV, or BEV, its (2014 or 2015 model year) MSRP is used and incremental prices are calculated relative to the nearest option (in terms of electric mode and range) in Table 1.
2. For PHEVs the indicated range is only the distance they travel while powered solely or substantially by electricity stored in their batteries. Otherwise, PHEVs may travel distances similar to conventional ICEVs between fueling with gasoline.

Prices for upgrading home PEV charging and the duration to charge different PEVs are in Table 2. Home hydrogen fueling was priced at $7,500 and required electricity at the home parking location.

Table 2: Prices and charging times for combinations of electrical service and PEV type

Prices to upgrade home PEV charging to:			
	1kW	3kW	6kW
Existing electricity at home parking:			
None	Shown prices as if they had 110V service (see below) and a reminder they said they had no electricity at their home parking location.		
110V	0$	$1,300	$2,000
220V	—	$300	$1,000
EVSE	—	—	—
Range of charging duration options, hours			
Sub-compact or compact PHEV-10 Assist	~1	< 1	<1
Full-size BEV-300	161	55	27
Price to upgrade to home hydrogen fueling			
$7,500 plus electricity must be available at the home parking location.			

Incentives offered for PHEVs, BEVs, and FCEVs in the final design game are shown in Table 3. All qualifying vehicles are assigned the federal incentive. In addition, respondents choose only one of the other incentives (shaded in Table 3). This procedure means most respondents in California are "under-incentivized" compared to incentives available at the time of the study: they would have been eligible for both a state vehicle purchase rebate and single-occupant vehicle access to HOV lanes. They may also have been eligible for local purchase, parking and toll incentives depending on their residence location and daily travel routes. Workplace charging is typically not offered anywhere tied specifically to any household's vehicle. Conversely, as the on-line survey was jointly administered in several other states, respondents in some of those states are "over-incentivized" as only the federal incentive is available to them. Framing the incentives as was done in these games allows for both an assessment of the effects of a financial purchase incentive (the federal incentive assigned to all qualifying vehicles) and the attractiveness of a variety of other additional incentives.

Table 3: Incentives for PHEVs, BEVs, and FCEVs offered in final design game

		Respondents choose only one:				
	Federal vehicle incentive	State vehicle rebate	Home charging/ fueling rebate	HOV lane access[1]	Reduced bridge and road tolls[1]	Work-place charging
Assist PHEV-10	$1,500	$1,000	$1,000			
Assist PHEV-20	$2,500	$1,000	$1,000			
Assist PHEV-40	$3,500	$1,000	$1,000			
Assist PHEV-80	$6,500	$1,000	$1,000			
All- Electric PHEV-10	$2,500	$1,000	$1,000			
All-Electric PHEV-20	$4,000	$1,000	$1,000			
All-Electric PHEV-40	$5,500	$1,000	$1,000			
All-Electric PHEV-80	$6,500	$1,000	$1,000			
BEV-50	$7,500	$2,500	$2,500			
BEV-75	$7,500	$2,500	$2,500			
BEV-100	$7,500	$2,500	$2,500			
BEV-125	$7,500	$2,500	$2,500			
BEV-150	$7,500	$2,500	$2,500			
BEV-200	$7,500	$2,500	$2,500			
BEV-300	$7,500	$2,500	$2,500			
FCEV-all	$7,500	$5,000	$5,000			[2]

1. HOV lane access and reduced tolls were stipulated to last until January 1, 2019.
2. Workplace fueling for FCEVs was not offered.

In the games, the sub-total of any incremental vehicle price (Table 1) plus any charging or fueling upgrades (Table 2) is shown as a line item in the total cost calculation. In the final game, the amount of the federal incentive and the incentive a respondent selects (Table 3) are shown as additional line items in the total price section.

The results of the design games were respondents' prospective designs for a new vehicle they imagined they would buy next. These prospective designs are not forecasts, but indicators of respondents' present positive or negative valuation of ZEVs. The games provide a way for respondents to register whether they are presently willing for their next vehicle to be a PEV or FCEV within the conditions of the design games.

Interview Design

Interviews were completed to: 1) describe the variety of reasons people have for forming positive or negative purchase valuations toward ZEVs and ZEV-enabling technologies; 2) describe the variety of motivations for different ZEVs and ZEV-enabling technologies; 3) describe the variety of “negative” intentions, e.g., are they grounded in lack of awareness, knowledge, and motivation or actual opposition to ZEVs and ZEV-enabling technology; and 4) characterize the variety of responses to questions too complex to be adequately addressed in the online survey. An example of the latter is whether and how households compare costs across familiar, conventional vehicles and new-technology vehicles.

The interviews improved understanding of decision-making and of whether and how ZEVs and ZEV-enabling technologies fit within or reshape trajectories of household narratives. The interviews do not represent all households but provide descriptions that are illustrative of how and why some people make the decisions they do. Further, the opportunity for households to frame questions, and address issues in their own words reveals their interpretations and provides language for education and outreach programs, marketing, and subsequent research. Overall, the interviews inform the interpretation and evaluation of the present large sample survey. In particular, the interviews probed for more details and explanations of the items listed under Objective 1, gave the households an opportunity to elaborate on their thoughts during the design games, and probed specifically for the role of body styles on the prospects for ZEV sales.

Sampling and Samples

At the time this study was conducted at the end of 2014 almost anyone wanting a PEV or FCEV would have had to acquire it as a new vehicle. Thus, the population for this study is households who buy new vehicles. It is known that some households who have not purchased new vehicles—recently or ever—will purchase a new vehicle in response to the offerings of PEVs and FCEVs. However, the decision was made to focus on households who had shopped for and bought new vehicles during the period of initial PEV offerings.

Survey

The University of California, Davis hired a sample management services company to recruit and incentivize study participants. The University provided the vendor with household selection criteria and the target sample sizes; the firm invited the participation of new car owning households, sent reminders to participants, and provided sample weighting to insure the realized sample of completions represents the target population of new-car buying households. Potential respondents were drawn from four existing panels: American Consumer Opinion Panel (ACOP), SSI, Exchange, and Nielsen. Potential respondents were offered US$5 to complete the survey.

Respondents were invited to the study via email. The email included a link to a screening questionnaire hosted by the survey sample vendor to establish respondent’s eligibility for the study. Eligible participants must have at least one such household vehicle and have purchased or leased one of these new since January 2008. Additionally, the respondent had to be at least 19 years old (for purposes of providing consent to participate). The screener also confirmed respondents’ zip codes to assure state quotas were met.

Eligible respondents were presented a link to the primary study questionnaire hosted on a UC Davis computer server. The questionnaire was designed for a wide variety of operating systems for PCs and tablets but not smartphones. Invitees who did not complete the questionnaire were emailed reminders from the vendor. The questionnaire's URL was active for one month during the period December 2014 to January 2015.

Table 4 shows the target sample sizes for each state, as well as the number of follow-up interviews in those states requesting them. State sample sizes were determined largely by the sample provider's ability to provide samples from the population of new-car buying households in each state. The maximum achievable sample size was used; in the case of California, the target sample size was n = 1,700. Following data cleaning primarily for records too incomplete to be useful, the final sample size for California is n = 1,671. Similar cleaning of all other data records resulted in a useful sample of 5,654 records summed over all participating states.

Table 4: Survey sample size, by state

State/Region	Target size	Final sample size	Number of Interviews
California	1,700	1,671	36
Oregon	500	494	16
Washington	500	500	16
Delaware	300	200	0
Maryland	400	396	0
NESCAUM members			
Massachusetts	500	498	0
New Jersey	500	495	0
New York	1,000	997	0
Connecticut	184	180	0
Maine	69	69	0
New Hampshire	68	68	0
Rhode Island	54	54	0
Vermont	32	32	0
All States Total	5,807	5,654	68

Sample Representativeness

Completion rates

The sample vendor invited respondents from the four volunteer opt-in panels. The total number of initial contacts to these four pools is estimated to be 238,160. The number of responses in the final, cleaned database is 5,654 resulting in a "total completion rate" of 2.4%. As shown in Table 5, the single largest cause for this low value is the low rate at which initial invitations were converted into people starting the screening survey. It is not known how many of the 21,724 (29,770 – 8,046) who started the screening questionnaire but were not passed to the UCD survey were not passed because they did not complete the screening questionnaire or completed the screener but were not eligible to participate. Recognizing that any invitee who starts the UCD questionnaire is already among the eligible and most willing to participate, the completion rate among those who actually started the UCD questionnaire was 70.3 percent.

Table 5: Summary of Overall Survey Response Rates

	Number	Percent of previous line number	Cumulative total completion rate, %	Cumulative completion rate from start of UCD survey, %
Total initial invitations:	*238,160*			
Started screening pre-survey:	29,770	12.5[1]		
Passed to opening page of UCD survey:	8,046	*27.0*		
Consent to study (complete first page) = 100 – bounce rate[2]:	*7,322*	*91.0*		
Completed UCD survey:	5,711	78.0		
Total after initial cleaning[3]:	5,654	*99.0*	2.4	70.3

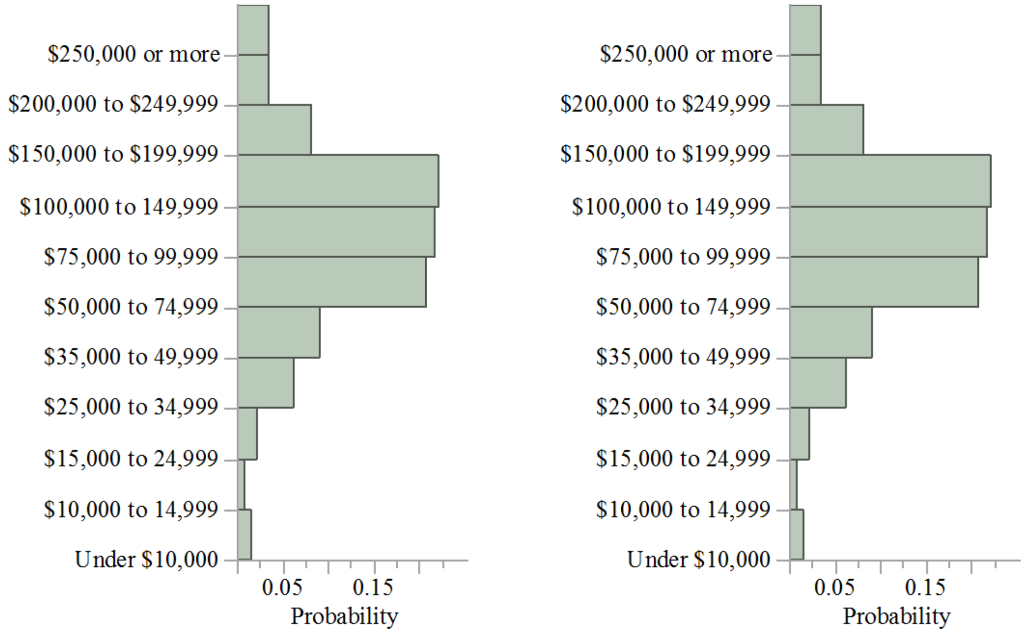
Note: Italicized values calculated from known values.
1. This is the value for the ACOP panel. It is unknown for the other three panels. The computed value for total initial invitations assumes the same rate for those other panels.
2. Bounce rate is the percent of respondents who open the first page but leave before completing it. In this case, the bounce rate was 9 percent.
3. Initial cleaning removes only clearly invalid or grossly incomplete responses. It allows there will be a few remaining instances of missing or incongruent values within some respondent records.

Sample Weighting

The sample vendor developed weights using an independent, contemporaneous, proprietary sample of households who had purchased a new vehicle since 2008. In general, the results presented in this report are unweighted. The primary reason is that using the weights comes at a cost with little to no benefit. The cost is the weights routinely produce estimates with larger variances than the unweighted estimates. The lack of benefit is the lack of either any change to our substantive understanding of the results or a reason to weight the results to achieve a more representative value. At the risk of pre-empting the presentation of results in the next section, see the example of household income in Figure 2. The variance of the weighted mean is higher (2.52 income categories) than the unweighted (1.92). However, the sample means are not different at $\alpha = 0.05$, every listed quantile below the figure is identical, and the substantive interpretation of the income distribution is unchanged.

Figure 2: Unweighted and Weighted Estimates of the Distribution of Household Income

Unweighted Results | **Weighted Results**



Unweighted Results

Quantiles		
100.0%	maximum	11
99.5%		11
97.5%		11
90.0%		9
75.0%	quartile	8
50.0%	median	7
25.0%	quartile	6
10.0%		4
2.5%		2.8
0.5%		1
0.0%	minimum	1

Summary Statistics	
Mean	6.8312388
Std Dev	1.9231351
Std Err Mean	0.0470459
Upper 95% Mean	6.9235139
Lower 95% Mean	6.7389637
N	1671
Sum Wgt	1671
Sum	11415

Weighted Results

Quantiles		
100.0%	maximum	11
99.5%		11
97.5%		11
90.0%		9
75.0%	quartile	8
50.0%	median	7
25.0%	quartile	6
10.0%		4
2.5%		2.8
0.5%		1
0.0%	minimum	1

Summary Statistics	
Mean	6.9940359
Std Dev	2.5238091
Std Err Mean	0.0515852
Upper 95% Mean	7.0952144
Lower 95% Mean	6.8928574
N	1671
Sum Wgt	2393.6596
Sum	16741.341

Are there comparable samples?

Ideally the representativeness of the sample in the present study (UCD) would be established by comparison to an arbitrary number of samples of arbitrary size drawn in an unbiased manner from the population of interest. This ideal is unobtainable in this specific instance as it is in any practical application of survey research. For reasons discussed next, we argue that what can be gained in confidence about how well the UCD sample represents its intended population by comparing the UCD sample to other samples of other populations is unknown and likely unknowable. Generally, the reasons are a lack of the same measures across datasets and differences in definitions of shared measures and sampling procedures, as well as samples drawn at different times, by different means, from different populations.

Though the US Census attempts to enumerate the total US population, it lacks measures required to generate a sub-sample of households who acquire new motor vehicles, i.e., it can't provide an enumeration of the population studied here. The American Community Survey (ACS) shares the same problem. Looking at datasets more closely related to the subject of this study, there are no driver or household socio-economic and demographic data in the California New Car Dealers' Association (CNCDA) California Auto Outlook. Further, CNCDA vehicle data in the Outlook are for vehicles sales, not household vehicle holdings. The 2010-12 California Household Travel Survey (CA HTS) may be the most relevant data set for comparison, but we argue it is sufficiently different that its use as a standard to judge how well the UCD sample represents its intended population is limited.

First, we are not trying to represent a population as of 2012 (the year of data collection for the CA HTS).[14] Given the effects of the extended recovery from the recent recession on employment, home ownership, household vehicle purchase, ownership and travel, household incomes, wealth, etc., we expect there to be differences between the CA HTS and the sample for this study because of the two to three years difference in the dates of data collection.[15] Further, the period between the two studies was dynamic regarding the specific topic of the UCD study—the introduction of PEVs and FCEVs. In the interval between the closing of data collection for the CA HTS and the closing of data collection for the UCD study, four vehicle manufacturers (Cadillac, Hyundai, Kia, and Volkswagen) newly introduced PEVs into the California market and a fifth, BMW, barely beat the closing of data collection for the CA HTS to also be classified as a new entrant in the interval between the two samples. (Using Clean Vehicle Rebates (CVRs) as a proxy for vehicle sales, only 70 CVRs were paid for a BMW PEV on or before 31 January 2013; 858 CVRs were paid between then and the closing of data collection for this study on 6 January 2015 (https://cleanvehiclerebate.org/rebate-statistics)).

Second, basic concepts are operationalized differently in the UCD and CA HTS studies based on how questions are asked, i.e., the medium in which the surveys were conducted as well as how questions and answers were worded. For example, compare how household size was defined and measured. In the UCD study, the survey is self-administered; respondents answer questions they

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[14] Data collection for the most recent CA HTS started at the beginning of February 2012 and closed at the end of January 2013.

[15] Data for the UCD "New Car Buyers' Valuation of Zero-Emission Vehicles" study opened in mid-December 2014 and closed a few weeks later in early-January 2015.

read in an online questionnaire. Respondents are given this definition of their household at the start of their questionnaire:

> "Your 'household' includes all the adults with whom you currently live and jointly make financial decisions such as vehicle purchases, and any of your children living with you. If you live alone, then you are your household."

Then in the final section of their questionnaire they are asked, "How many people are in your household?" They answer by selecting one of eight radio buttons labeled with integer values from 1 to 7 and "8 or more."

In the CA HTS survey, the question regarding household size is asked during a recruitment survey administered by an interviewer via telephone. In the CA HTS respondents are asked their household size:

> "How many people, including yourself, live in your home? Please include foster children, roommates, and/or housemates. Do not include college students away at school or people who live at another place most of the time."

The interviewer records the respondents' answers as an integer from 1 to 15 (or 98 for "Don't know" or 99 for "Refused").

The definition of a basic unit of analysis differs between the two studies both in how the data were collected and what constitutes a household. First, the sample for the UCD study samples was generated from a subset of the relevant population who has internet-access while the CA HTS samples people who can be reached via telephone. While it may be that new car buyers can be reasonably expected to have both internet-access and telephones, it remains true that access to the two sampling frames can produce differences in which households are likely to respond. Further, we are aware of no evidence that privileges either these two sampling frames as providing unbiased access to the intended population.

Second, the differences in question wording and response format can be expected to cause differences in measures of household size between the two studies. The definition of a household for the UCD study of consumer response to PEVs and FCEVs seems likely to produce more households with fewer people (and thus also things that depend on household size such as total number of vehicles and household income) as it specifies there must be a decision-making nexus between adults. In contrast, the CA HTS explicitly asks respondents to include "roommates and/or housemates," which respondents may assume include people who do not share decision making about things such as vehicle purchases. Specifically, the CA HTS question seems likely to be understood to be asking for an enumeration of all people living at the respondent's address regardless of relationship. The two definitions may be appropriate to the research questions of their respective studies. The UCD study examines potential household vehicle purchase (and use to the extent the two are dependent). To the extent a roommate may also live in the household but be irrelevant to the respondent's vehicle purchases, the UCD study is less concerned with the presence of such roommates. On the other hand, the CA HTS is concerned with producing estimates of total vehicle travel (among other things) in the state, thus data on all household members is more important to the CA HTS goals.

Given such differences in definitions, question and answer phrasing, survey media, sampling methods, and timeframes, comparisons of the UCD study sample to the CA HTS (and by extension, most any other sample) introduce several potential reasons to believe that measures of even what seem like basic facts will differ.

Example comparisons to the 2010-12 CA HTS

With this extended caution, we excerpt the household and vehicle data from the CA HTS for households that most nearly match the operationalization of "new car buyer" used in the UCD study: a household that had acquired at least one new vehicle within the six years prior to the survey, i.e., since January 2008. For the CA HTS we use January 2006 as the cutoff. Thus the model years differ but the duration of the intervals over which we attempt to observe the acquisition of new vehicles are the same. Even here though, what counts as a household vehicle differs between the two studies.

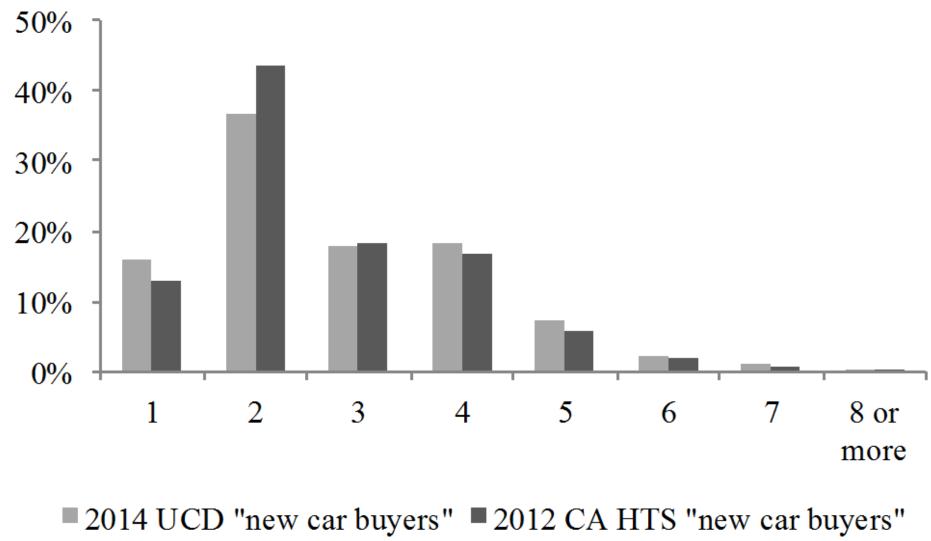
> UCD: "How many vehicles does your household currently own or lease, that are driven at least once per week? (Count cars, trucks, vans, minivans, or sport utility vehicles, but do not include motorcycles, recreational vehicles, or motor homes.)"
>
> CA HTS: "How many motor vehicles are owned, leased, or available for regular use by the people who currently live in your household? Please be sure to include motorcycles, mopeds, and RVs."

Even excluding motorcycles, mopeds, and RVs from the CA HTS counts of household vehicles, there is the more specific stipulation in the UCD study that the vehicles be driven at least weekly contrasted with "available for regular use" in the CA HTS. Further, vehicles "available" to the household are not solicited in the UCD question.

The unweighted sample size of the 2010-12 CA HTS is 42,431 households. The subset meeting as closely as possible the UCD definition of new car buyers contains 16,595 households. The percentages of the five most prevalent recently acquired new vehicle makes are similar between the two samples: Chevrolet (7% both), Ford (10% CA HTS, 11% UCD), Honda (14% both), Nissan (6% both), and Toyota (23% CA HTS, 19% 2014 UCD). These five manufacturers sum to 61% of recently acquired new vehicles in the CA HTS sample and 57% in the UCD sample.

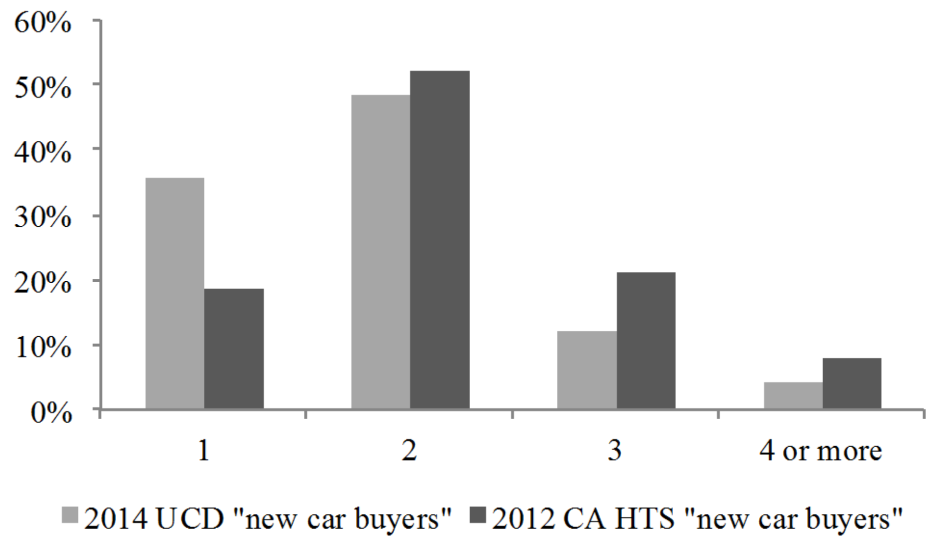
At the further risk of getting ahead of the presentation of this study's results, the next few figures compare household size, number of vehicles, and household income from the UCD study and the most recent (2010-2012) CA HTS. As argued above, the differences in the prevalence of households of different size shown in Figure 3—specifically the higher prevalence of households with fewer members in the UCD sample—may simply be due to the different definitions of "household" in the two studies. A single adult with an adult roommate with whom they do not make joint vehicle purchase decisions is a one-person household in the UCD study but would be a two-person household in the CA HTS. (Though it may appear in Figure 3 that the UCD study also has too many households with four or more members compared to the CA HTS, all those differences are less than two percentage points.)

Figure 3: Household size in the UCD and 2010-12 CA HTS samples



Given the observed differences in household size and differences in the definition of household vehicles, we expect there to be more households with fewer vehicles in the data for the UCD study than in the CA HTS data—as we see in Figure 4.

Figure 4: Number of household vehicles in the UCD and 2010-12 CA HTS samples

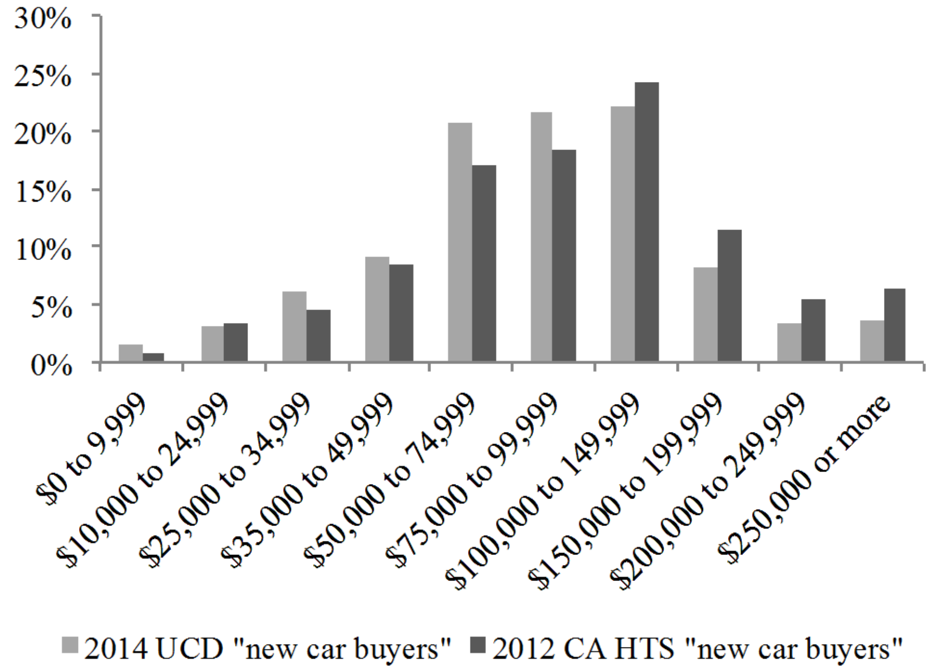


We might also expect based on the differences in definitions of households that the UCD households would be more likely to report lower incomes than the CA HTS households. If respondents in the UCD study are excluding people with whom they do not make financial decisions such as vehicle purchases—as they are instructed to do—it seems plausible they would omit those people when estimating their households' past year's income. The wording of the income question in the CA HTS survey reinforces this expectation that results will differ between the UCD and CA HTS:

> "To make certain our study represents all income groups in California, could you tell me if your total household income *(total incomes for all persons living in the household)* for last year was above or below $25,000?" [Emphasis added.]

This expected difference is exactly what is shown in Figure 5.

Figure 5: Household's Past Year's Income in the UCD and 2010-12 CA HTS samples



In summary, the available evidence suggests that the sample collected for the present study is at least similar to other samples—within the boundaries of sampling errors given the sample sizes—on metrics available in all the samples compared (whether those comparisons are explicit as in the case of the CA HTS or implicit in the assessment of the effect of the use of weights derived from another study of new car buying households). Interpretations of observed differences between the UCD and CA HTS are confounded by differences that can be expected given differences in definitions of basic concepts. Given other sources of potential difference such as the period of data collection and the questionnaire media it is plausible that the earlier discussion of sample weighting provides as useful a metric as any for whether the UCD sample adequately represents new car buyers—as that concept is operationalized in the UCD sample—as any.

Interviews

The overall study design includes follow-up interviews with survey respondents. These interviews were conducted in Washington, Oregon and California. The final questions in the on-line questionnaire asked whether respondents were willing to speak to us further about their responses. The interview sampling procedure produced a stratified sample based on the vehicle designs. The main stratification variables were 1) drivetrain type (ICEV or HEV vs. PHEV, BEV or FCEV) and 2) vehicle body style and size. In California, interviews were conducted in March 2015. Interviews were conducted in the Sacramento, San Francisco Bay, San Diego, and Los Angeles areas.

Analytical Tools

Survey data are analyzed with statistical tools ranging from single variable counts to models testing for correlations between multiple variables simultaneously. The results sections that follow build in this pattern from basic frequency distributions of single variables to tests of means and distributions of one variable across values of a second variable to multivariate modeling. Substantively, the progression of analysis and results is from description of the on-line survey responses to exploration of who does and who does not have a sufficiently high valuation of PEVs and FCEVs to consider one for their household.

Nominal logistic regression

For variables that have only discrete possible values, the mathematical tool for exploring which other multiple variables are correlated with them is logistic regression. The measure of respondents' valuation of ZEVs is the drivetrain type of the vehicle they design in the final design game. This variable has five distinct possible values: ICEV, HEV, PHEV, BEV, or FCEV. These five possibilities are assumed to not have a particular order, but simply to be five nominal categories. This assumption affects the mathematical estimation of the model, specifically, how many parameters have to be estimated, as well as the interpretation of those parameters. Thus the specific name of the form of logistic regression used here nominal logistic regression. Further details are provided in Appendix D.

Principal Components Analysis

Principal components analysis is a statistical tool to search for smaller sets of concepts within a larger number of variables. In short, it determines whether a smaller number of "components" reveal underlying concepts and can adequately substitute for a larger number of variables. Whether the smaller number of components is "adequate" is determined by how much of the variance of the original variables is retained.

Principal components analysis is used in this study both to identify concepts and to allow testing for relationships between drivetrain designs and more concepts and variables. That is, it is not possible to test an arbitrarily large number of explanatory variables in the logistic regression equation. Principal components analysis can reduce the number of individual variables (by reducing many variables to fewer components) while preserving the ability to test more concepts.

Several concepts that may be correlated with the likeliness a respondent designs a vehicle incorporating one drivetrain or another were measured by multiple variables. For example, familiarity with the different types of drivetrain technology was measured by five separate questions, one each for ICEVs, HEVs, PHEVs, BEVs, and FCEVs. It may be the case that rather than being five independent concepts, collectively these five questions represent a smaller number of concepts. Perhaps there is only one concept—say, interest in cars in general. If that were true, then across a population of people we would expect those who score themselves highly on one measure would score themselves highly on all the measures. Again, if this is true, then the five variables could be reduced to one component. As it turns out in this specific example of familiarity with drivetrain types in the California sample, the five variables can be reduced to two components: 1) familiarity with HEVs, PHEVs, BEVs, and FCEVs and 2) familiarity with ICEVs. These two components are tested as explanatory variables in the nominal logistic regression rather than the five original variables. Similar analyses are conducted for: driving experience with HEVs, PHEVs, BEVs, and FCEVs; evaluations of the performance of PEVs and FCEVs prior to playing the design games; and, the pro-social goals for ZEVs, i.e., air quality, climate, and energy supply and security.

Cluster Analysis

Cluster analysis addresses the question of whether identifiable clusters of respondents exist based on their answers to multiple questions. Clusters are determined by the distances between values of several variables for each respondent from those values for other respondents. Respondents whose values are close on some variables form distinct clusters from respondents whose values are close on other variables.

Cluster analysis was used in this study to address the question of whether there are identifiable clusters of respondents who share motivations for why they did or did not design a PEV or FCEV. In short, after the design games those who designed a PEV or FCEV are asked why they did so and those who designed an ICEV or HEV are asked why they did not design a PEV or FCEV. These responses are labeled “motivations” to distinguish them from assessments of PEVs and FCEVs solicited prior to the design games. Within the on-line questionnaire there are 18 possible motivations for designing a PEV or FCEV and 19 possible motivations for not. Cluster analysis searches these two multi-dimensional spaces for whether the distribution of answers is essentially random or whether there are clusters of respondents who share motivations and can be distinguished from other clusters of respondents who share different motivations.

Analyzing Interviews

The household reviews were compared against each other to locate themes across households representing common experiences, ideas, and valuations across interviews. To identify themes in the data, the researchers conducted a three-step coding process: (a) open coding on the first reading to locate themes and assign initial codes, (b) axial coding on the second reading to review and examine initial codes, and (c) selective coding on the third reading to look for examples to illustrate themes

RESULTS: WHO ARE THE NEW CAR BUYERS IN THE CALIFORNIA SAMPLE?

We first present a description of the survey sample according to characteristics of the respondents and their households, vehicles, travel, residences, and awareness, knowledge, and attitudes toward ZEVs and the policy goals for ZEVs. Comparisons are made to the total sample across all states, in lieu of a comparison to other samples of new car buying households in California. The analysis of those ZEV valuations is presented in the subsequent section. The measure of valuation of ZEVs is the vehicle design in the last (of up to three) design games. [16]

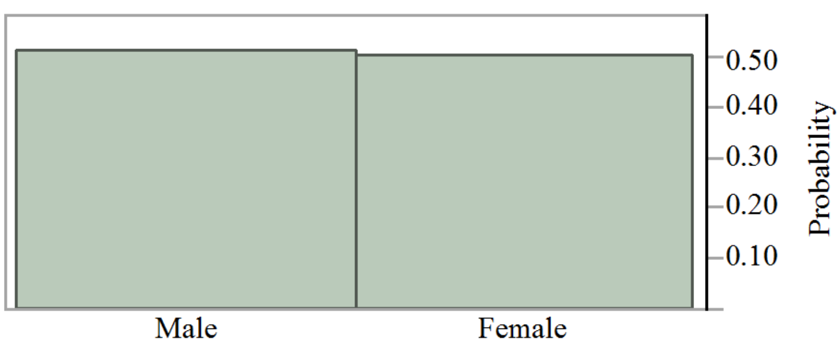
Socio-economics and demographics

- Overall, there are few differences between the CA sample and the total sample.

The respondents and their households are described here in terms of socio-economic and demographic variables. This allows comparison of the California sample to the other available sample of new car buyers—the total sample from all states. In part, the reason for this is to understand whether readily available socio-economic and demographic data may explain ZEV valuation, as opposed to custom studies (such as this one). Further, early PEV buyers have been predominately male, middle age, higher income, and possess graduate degrees. Understanding how new car buyers who don't fit this profile think about ZEVs will be essential to growing markets.

The CA sample was balanced nearly 50/50 female/male (Figure 6) compared to the 52/48 split of the total sample. Evidence from California's Clean Vehicle Rebate program and reports from vehicle manufacturers indicate that early PEV buyers have been disproportionately more likely to be male than female. The age distribution of the CA (Figure 7) and total samples are similar.

Figure 6: CA Respondent gender

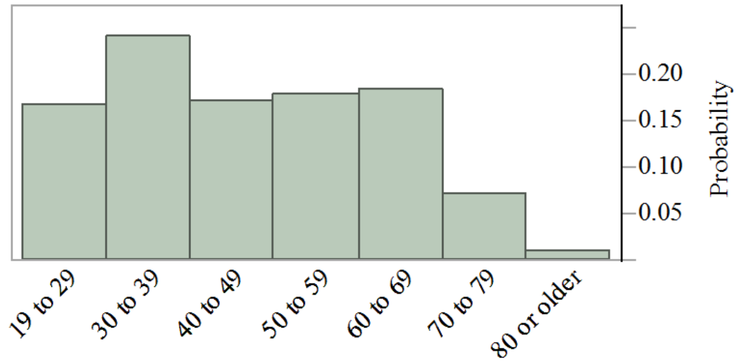


Frequencies

Level	Count	Prob
Male	843	0.50449
Female	828	0.49551
Total	1671	1.00000
N Missing	0	
2 Levels		

[16] Frequency responses for individual survey items are provided in Appendix E.

Figure 7: CA Respondent Age



Frequencies

Level	Count	Prob
19 to 29	269	0.16313
30 to 39	392	0.23772
40 to 49	280	0.16980
50 to 59	290	0.17586
60 to 69	296	0.17950
70 to 79	112	0.06792
80 or older	10	0.00606
Total	1649	1.00000
N Missing	22	
7 Levels		

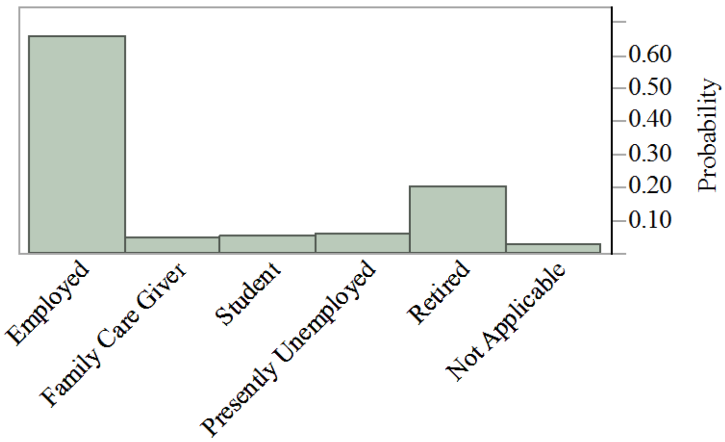
The distribution of respondent's employment status are similar between CA (Figure 8) and the total sample; across both samples, ~60% are employed in the paid labor force and ~20% are retired. The rest are small percentages each of people who are family caregivers, students, presently unemployed, or otherwise classified as "not applicable." While 19% of individual respondents in CA are retired, 26.5% of the households they represent contain at least one retired person. Sixty-five percent of respondents report no children (persons younger than 19) in the household. Those who do report children in the household are split as to whether the youngest reported member is younger than seven years old (16%) or is age seven to 18 (19%). All told, households range in size from one to eight or more members: most (87%) have one to four members (Figure 9).

The income distribution for the CA sample is nearly identical to that for the total sample (Figure 10). Despite being a sample of households who had recently purchased a new vehicle, reported annual household incomes includes households in the lowest income categories (as well as the highest). Some of these "low income" households may still be legitimate new car buyers if they have adequate sources of wealth, credit, or non-income earnings. The mean income categories for both distributions are nearly identical (CA, 6.8; total, 6.7) and the median category is 7 ($75k-$99k) for both.

The distributions of respondents' highest education level shows little difference: the CA sample is slightly more likely to have the equivalent of a high school education or less than the total sample. Still the median educational achievement for both samples is an undergraduate degree and approximately 30 percent of both samples have at least some graduate education.

To assess the extent to which respondents' valuations of PEVs may be politicized, we asked respondents their party affiliation. Political party affiliation in the CA sample (Democratic 48%; Republican 28%, Other 5%, and None 19%) is skewed by three percentage points toward the Democratic Party compared to that of the total sample—(Democratic 45%; Republican 28%, Other 6%, and None 21%). Compared to the February 2015 California Secretary of State's voter registration report, the CA sample also over represents Democrats and reverses the relative size of Other and None: Democratic 43%, Republican 28%, Others 5%, and Non-affiliated 24%.[17]

Figure 8: CA Respondent Employment Status

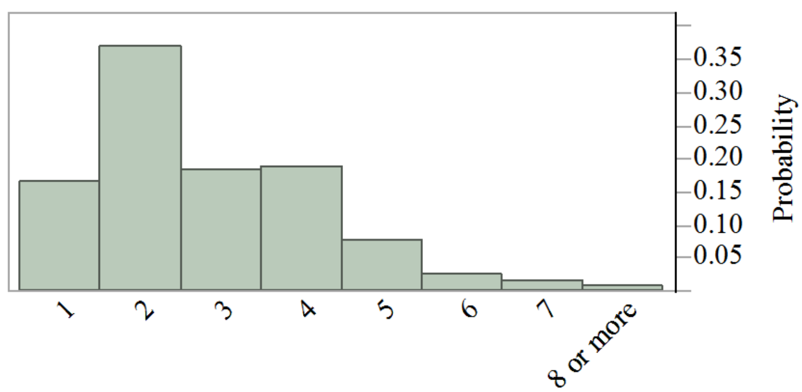


Frequencies

Level	Count	Prob
Employed	1051	0.64957
Family Care Giver	62	0.03832
Student	71	0.04388
Presently Unemployed	89	0.05501
Retired	312	0.19283
Not Applicable	33	0.02040
Total	1618	1.00000

N Missing 53
6 Levels

Figure 9: CA Household Size



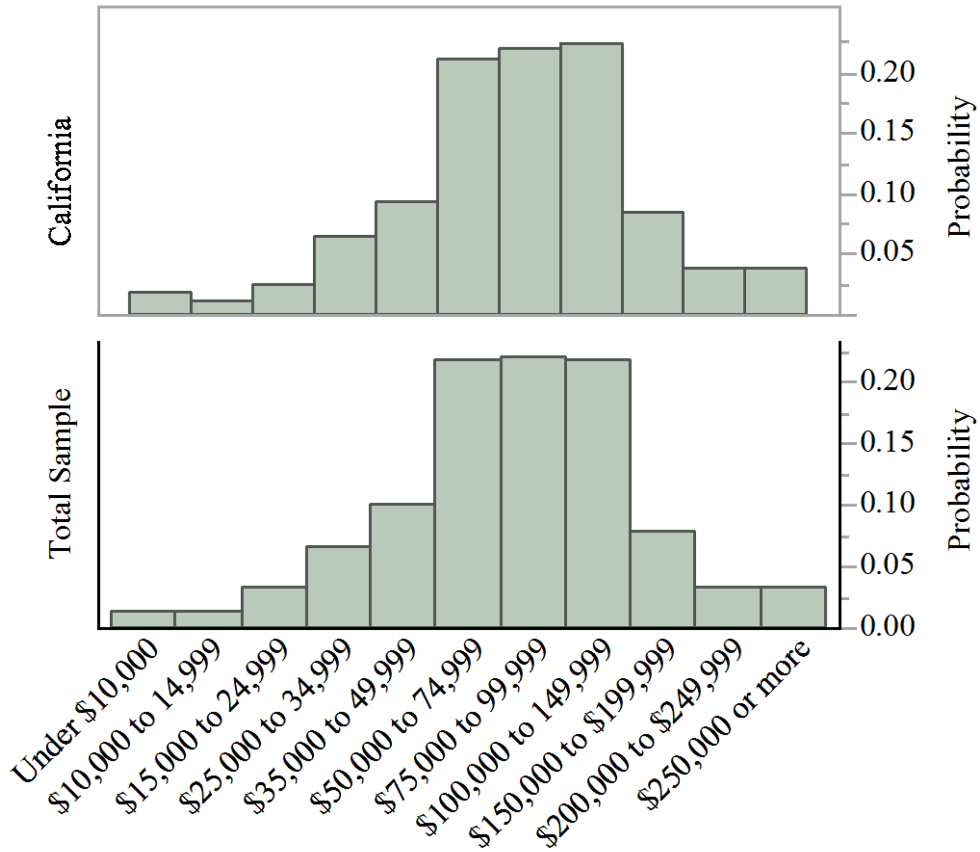
Frequencies

Level	Count	Prob
1	270	0.16158
2	610	0.36505
3	299	0.17893
4	307	0.18372
5	122	0.07301
6	35	0.02095
7	21	0.01257
8 or more	7	0.00419
Total	1671	1.00000

N Missing 0
8 Levels

[17] California Secretary of State Report of Registration February 10, 2015 Historical Voter Registration Statistics: http://elections.cdn.sos.ca.gov/ror/ror-pages/ror-odd-year-2015/hist-reg-stats.pdf

Figure 10: Annual Household Income, CA and Total Samples



Prior Awareness, Knowledge, and Valuation of ZEVs

Several concepts more specific to ZEVs, electricity, and hydrogen may be related to a respondent's propensity to design—or not—a PEV or FCEV as a plausible next new vehicle for their household. Among those concepts measured in the on-line survey are:

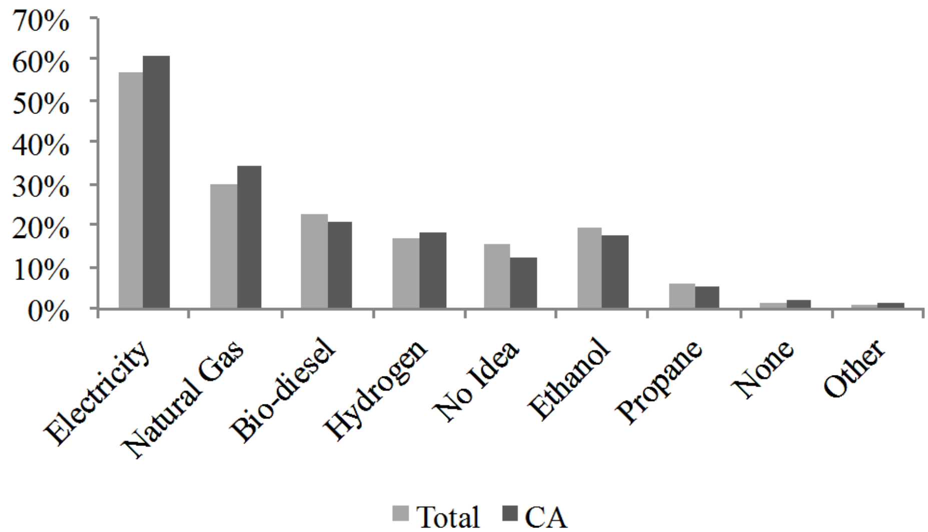
- Likely replacements for gasoline and diesel fuel;
- Attitudes toward climate change and air quality;
- Prior familiarity with the specific technologies that will be explored in the design games, i.e., HEVs, PHEVs, BEVs, and FCEVs;
- Perceived comparative risks of electricity and gasoline to health and the environment;
- Prior knowledge of the availability of incentives and belief whether the public sector should offer incentives;
- General interest in new technology and specific interest in "the technical details of vehicles that run on electricity or hydrogen and how they work."

Likely replacements for gasoline and diesel fuel

- Electricity wins.

The question was asked, "If for any reason we could no longer use gasoline and diesel to fuel our vehicles, what do you think would likely replace them?" Respondents could choose up to three fuels from the list: electricity, hydrogen, natural gas, ethanol, bio-diesel, propane, none, "I have no idea," and other.[18] Most people are willing to stipulate at least one replacement: only 15% of the CA sample and 17% of the total sample answer "None" or "No idea. Electricity was selected by a slightly larger majority of the CA sample (61%) than in the total sample (57%, Figure 11). The rank order of hydrogen is higher in the CA sample (4th) than in the total sample (5th).

Figure 11: Replacements for Gasoline and Diesel, percent selecting each replacement (up to three selections per respondent), sorted by rank order in California



When respondents who chose at least one replacement are next asked to pick the single most likely replacement (and to provide a reason why they believe it is most likely), the relative difference between electricity and the nearest competing replacements increases. The advantage of electricity over natural gas is not quite two-to-one when people choose up to three possible replacements for gasoline and diesel (61% electricity/34% natural gas); the advantage is more than three-to-one when a single most likely fuel is chosen (57% electricity/18% natural gas).[19] Hydrogen (the fuel for FCEVs) fares poorly compared to other fuels in the CA and total samples, selected by only 18% of respondents when they have up to three choices and by only six percent

[18] The list order was randomized across respondents.

[19] Compared to when they can choose up to three, the percent of people who select any single fuel must decline when they can choose only one as the total percentage across fuels is now constrained to be 100%.

when asked to pick the single most likely replacement. These are essentially the same as for the total sample.

The reasons why CA respondents think different options are the most likely to replace gasoline and diesel are explored in Table 6; reasons that are highly rated (as indicated by large, positive deviations) for each fuel are highlighted in **bold**. Reasons that distinguish electricity from the other possible replacements are that electricity is more likely to be said to "already [have] been proven to be effective" and "[be] best for the environment." To foreshadow discussions ahead, note that prior to being engaged explicitly in a discussion about PEVs later in the survey, respondents are not disproportionately likely to credit electricity with being "cheapest for drivers." Hydrogen shares the reason "best for the environment" with electricity, but is not disproportionately credited with any other reason.

Table 6: CA, Reason for Most Likely Replacement By Likely Replacement[1]

Count Deviation[2]	Electricity	Natural Gas	Bio-Diesel	Ethanol	Hydrogen	Total
It doesn't need to be imported from foreign countries	80 -13.60	35 5.49	15 1.43	21 6.364	10 0.32	161
It has already proven to be effective	**219** **55.05**	23 -28.69	15 -8.78	21 -4.64	4 -12.95	282
It is cheapest for drivers	109 -20.65	**66** **25.13**	18 -0.80	22 1.73	8 -5.41	223
It is safest for drivers	51 -12.37	28 8.02	14 4.81	10 0.09	6 -0.55	109
It is the best for the environment	**273** **31.73**	49 -27.06	25 -9.99	21 -16.73	**47** **22.05**	415
It is the most abundant in the United States	36 -15.16	**32** **15.87**	5 -2.42	9 1.00	6 0.71	88
It will require the least amount of change for drivers and fuel providers	25 -25.00	17 1.24	**23** **15.75**	**20** **12.18**	1 -4.17	86
Total	793	250	115	124	82	1364

1. Table 6 excludes the three least mentioned replacements (propane, none, and other) as well as the least mentioned reason (other).
2. Deviations are calculated as the difference between the observed count (shown as the upper number in each cell) and the "expected value," where expected values are calculated by multiplying the corresponding row and column totals for each cell and dividing that product by the total sample size. Thus, the expected value for "it doesn't have to be imported from foreign countries: bio-diesel" is (161x115)/1364 = 13.57. The deviation is 15 – 13.57= 1.43. Negative deviations indicate fewer people give that reason than expected.

Attitudes toward clean air, climate change and a shift from oil

- On average, compared to the total sample the CA sample:

- Agrees more strongly there is an urgent national need to switch from gasoline;
- Agrees more strongly that air quality represents a threat in their region, they personally worry about air quality, and changes in individual lifestyle make a difference.

- On average and with caution that averages can hide a wide variety of beliefs, CA respondents are nearly identical to the total sample in their agreement with statements about global warming and climate change.
  - Respondents agree global warming is real, is caused by humans, can be affected by changes in lifestyle, and that immediate action is required.

As environmental and energy goals are the drivers for government policies requiring and encouraging ZEVs, it may be that respondents' attitudes about these goals will be important to their valuation of the vehicles themselves. Several questions were asked regarding these goals; most were asked in a format of agreement/disagreement with a statement. A score of -3 = strongly disagree and 3 = strongly agree; non-responses and "I don't know" were tallied separately. Scores shown here are based only on those on the agree-disagree scale.

Without stipulating why it might be necessary, respondents were asked whether, "There is an urgent national need to replace gasoline and diesel for our cars and trucks with other sources of energy." Answers are on a scale from strongly disagree (-3) to strongly agree (3). On average, the California sample registers slightly stronger agreement with the urgency of a change than does the total sample (mean scores: CA, 0.95; total sample, 0.84—the difference is statistically significant at $\alpha \leq 0.05$). The median values are well above zero (CA: 1.29, Total, 1.09), indicating more than half the respondents agree—to some degree—in the national urgency to replace gasoline and diesel.

Californians are more concerned about air quality and more likely to agree individuals can affect it compared to the total sample. On average, this sample of new-car buyers in CA is far more likely to agree with the statement, "Air pollution is a health threat in my region" than is the total sample: the mean score on the scale of -3 (strongly disagree) to 3 (strongly agree) is 1.06 in CA and 0.53 for the total sample ($\alpha \leq 0.05$). Further, the CA sample is on average more likely to agree with the statements, "I personally worry about air pollution," (1.15 vs. 1.02, $\alpha \leq 0.05$) and "Air pollution can be reduced if individuals make changes in their lifestyle" (1.74 vs. 1.67, $\alpha \leq 0.05$). For these three questions the percentage of the CA sample scoring at the highest level of agreement exceeds that of the total sample by five to 7.5 percentage points.

In contrast to air quality, the distributions of responses for the CA and total samples are nearly identical for global warming and climate change. Both the CA and total samples are on average more likely to agree "there is solid evidence the average temperature on Earth has been getting warmer over the past several decades": CA, mean = 1.21 and total sample =1.18. (The difference is not statistically significant). Among those who believe there is evidence for global warming, on average they believe it is caused by human action (3) rather than natural causes (-3): the mean score for CA is1.57; total sample mean = 1.51. (The difference is not significant at a threshold $\alpha \leq 0.05$, but is if $\alpha \leq 0.10$ is acceptable.) Similar results hold for whether the respondents agree or disagree. "Climate change can be reduced if individuals make changes in their lifestyle": the mean level of agreement is slightly higher in CA but concluding the difference is statistically significant depends on adopting the less stringent $\alpha \leq 0.10$ threshold.

While the overall distributions on a question about whether action should be taken on climate change appear similar between CA and the total sample, CA is slightly more polarized than the total sample. More CA respondents are at either end of the spectrum (immediate action is required vs. no action is required) (Table 7). While the differences between the distributions are significant ($\alpha \leq 0.05$), substantively the data in Table 7 indicate large majorities in both samples favor immediate action and small minorities think no action is required.

Table 7: Urgency to address climate change (choose one) [1]

	CA	Total
Human-caused climate change has been established to be a serious problem and immediate action is necessary.	59%	57%
We don't know enough about climate change or whether humans are causing it; more research is necessary before we decide whether we need to take action and which actions to take.	32%	35%
Concerns about human caused climate change are unjustified, thus no actions are required to address it.	9%	8%

1. Totals may sum to more than 100% because of rounding.

Prior awareness, familiarity, and experience with HEVS, PEVs, and FCEVs

- Overall, awareness of HEVs, PEVs, and FCEVs is so low that the reasonable assumption is most new car buyers' assessments prior to the design games are based largely on ignorance. In completing their design games, the vast majority of respondents are constructing their valuations for the first time.
- BEV name recognition is not pervasive across the sample and is limited to two vehicles.
    - Lack of familiarity with the distinctions between BEVs, PHEVs, and HEVs is a likely explanation for why respondents name PHEVs when asked for makes and models of BEVs.
- The measures of prior consideration show new car buyers in California are more likely than those in the other study states to have already purchased, shopped for, or at least gathered information on BEVs and FCEVs.

Prior awareness and familiarity with HEVs, PEVs, and FCEVs were measured in several ways. Respondents were asked:

- Whether they can name one of each of an HEV, BEV, PHEV, and FCEV presently sold in the US;
- Whether they are "familiar enough with these types of vehicles to make a decision about whether one would be right for your household," whether they have seen PEV charging locations in the parking lots and garages they use, how much driving experience they have with each of HEVs, BEVs, PHEVs, and FECVs, and questions about their impressions of BEVs and FECVs.
- Whether they have seen PEV charging locations in the parking lots and garages they use;

- How much driving experience they have with each of HEVs, BEVs, PHEVs, and FCEVs; and,
- About their impressions of several attributes of BEVs and FCEVs in comparison to ICEVs.

BEV name recognition is low in California and limited to two vehicles.[20] Asked, "Can you name an electric vehicle that is being sold in the US," 37% say "no"; 35% correctly name a BEV presently for sale, leaving 28% who name a vehicle that is not a BEV presently for sale in the US.[21] Among those who correctly name a BEV, just two vehicles account for 91% of correct responses: Nissan Leaf (41%) and Tesla (50%). The most commonly misidentified vehicle is the Chevrolet Volt: of all the people who offer the make and model of a vehicle that might have a plug (whether it is an BEV or not), 22% name this PHEV. In addition to misclassifying the Chevrolet Volt, the Toyota Prius is also frequently named as a BEV (13% of makes and models of vehicles that might have plugs). However, it is not clear people recognize the difference between the Prius (an HEV) and the Plug-in Prius (a PHEV), and never mind both are incorrect responses to a question about naming BEVs. This distinction between HEVs, PHEVs, and BEVs is one that analysts proficient with ZEVs make easily, however the result reported here and those upcoming in this section suggest the public is confused about the concepts of HEVs and PHEVs, perhaps even more so than they are about BEVs.

Responses to the question, "Are you familiar enough with these types of vehicles to make a decision about whether one would be right for your household?" were made on a scale from -3 (unfamiliar) to 3 (familiar), allowing a distinction of the 0-point of the scale (I'm neither unfamiliar nor familiar) from "I'm unsure." The first distinction between ICEV, HEV, PHEV, BEV, and FCEV vehicles in Table 8 is the percentage of people who are unsure or decline to answer. As shown in Table 8, few respondents are unsure or unwilling to rate their familiarity with gasoline and diesel fueled ICEVs. However, the combined percentage of those unable or unwilling to do so rises from HEVs, BEVs, to PHEVs, to a maximum of one-third of respondents being unable or unwilling to rate their familiarity with FCEVs.

Given these results, summary statistics are reported only for those respondents willing to rate their familiarity (Table 8). The differences in the mean values are all significant at $\alpha < 0.001$ (Table 9), i.e., each mean value is statistically significantly smaller than the ones above it. Familiarity, on average, declines from ICEVs through HEVs, BEVs, PHEVs, to FCEVs.

[20] Analysis of name recognition is limited to BEVs due to the lengthy time required to clean data and the likeliness the same results apply to PHEVs and FCEVs.
[21] The rules for determining "right" and "wrong" BEV names are subject to disagreement. Three sets of rules were used to test for the effects of such disagreements. As can be inferred from the text, one set of rules allows any correct make and model of a vehicle that has a PEV variant—PHEV or BEV—as a "correct" answer to the question, "Can you name a BEV sold in the US?" Two sets of rules stipulate that if the make and model are correct, they do not have to stipulate the PEV variant when the vehicle is offered as an ICEV and any PEV (PHEV or BEV). However, if they go on to stipulate a PHEV variant, their response is then counted as incorrect in the set of rules that most strictly adheres to the original question. For example, if they reply, "BMW i3" they are counted as correct. However, if they go on to stipulate "BMW i3 REx," they are wrong under the most stringent rules. It is, as discussed in the text, the Chevrolet Volt that makes the most difference. If it is allowed as a correct answer, the percentage of Californians able to name a "BEV" for sale in the US rises from 35% to 47%.

Pairwise, the differences in mean familiarity scores are all statistically significantly different from each other at $\alpha \leq 0.01$; the differences confirm the rank order in Table 8.

For comparison, the mean and median scores for self-rated familiarity with all five drivetrain types for CA and the aggregate of all states are illustrated in Figure 12. That the mean scores are always lower (in absolute value) than the median scores indicates that a group of people rate themselves as very unfamiliar, thus pulling down the mean values.

This is illustrated in Figure 13 with data from CA. While nearly 40 percent of the respondents willing to offer any rating rate themselves as definitely familiar enough with BEVs to assess whether one is right for their household (score ~ 3), smaller concentrations are found at the dividing line between familiar and unfamiliar (0) and at definitely not familiar enough (-3).

Table 8: CA Respondents Unwillingness to Rate Familiarity with Non-ZEVs and ZEVs

	Unsure, %	Decline to state, %	Total Unsure plus Decline to state, %	Mean	Median	Inter-quartile range
ICEVs	4.4	1.5	5.9	2.37	2.82	2.41 to 2.89
HEV	12.4	2.6	15.0	1.70	2.64	0.95 to 2.87
BEVs	14.9	2.3	17.2	1.35	2.16	0.00 to 2.86
PHEVs	19.5	3.3	22.8	1.07	1.67	0.00 to 2.83
FCEVs	33.4	5.1	38.5	-0.37	-0.19	-2.80 to 1.57

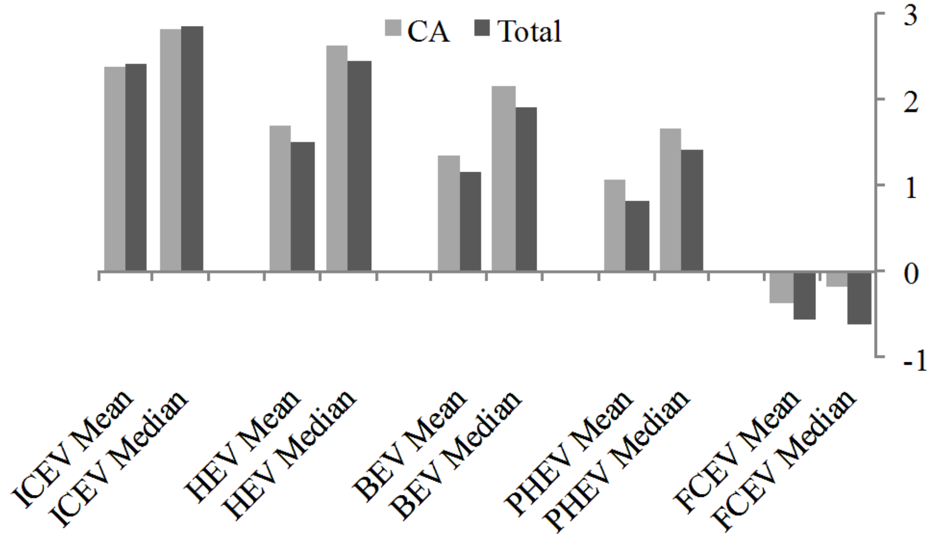
Table 9: CA, Differences in Respondents Ratings of Familiarity between ICEVs and HEVs and ZEVs, -3 = unfamiliar to 3 = familiar

Vehicle Type	Mean[1]	Mean Difference[2]	
ICEV	2.39		—
HEV	1.41	ICEVs - HEV	-0.98
BEV	1.14	ICEVs - BEVs	-1.25
PHEV	0.90	ICEVs - PHEVs	-1.49
FCEV	-0.33	ICEVs - FCEVs	-2.71

1. Means differ from Table 4 because they are estimated on a smaller (n = 885) set of respondents who provide a valid familiarity score for all five types of vehicles.

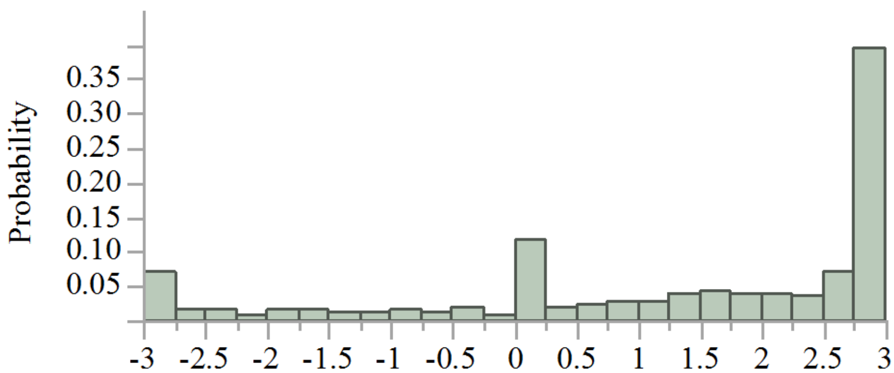
2. All differences statistically significant at $\alpha<0.01$.

Figure 12: Self-rating of familiarity with drivetrain types, mean and median scores for CA and the total sample, scale: -3 = No; 3 = Yes



Note: The question is, "Are you familiar enough with electric vehicles to make a decision about whether one would be right for your household?"

Figure 13: CA, Self-rating of familiarity with BEVs, -3 = no; 3 = yes; %



Note: The question is, "Are you familiar enough with electric vehicles to make a decision about whether one would be right for your household?"

If respondents are "familiar enough with [these types of vehicles] to make a decision about whether one would be right for [their] household," that familiarity was not gained through actual driving experience with any ZEV, ZEV-enabling technology, or even HEV. Measured on a similar scale of -3 (none at all) to 3 (extensive driving experience) and excluding those who scored themselves as unsure or declined to answer, the *mean* scores for CA respondents are all negative (HEVs. -1.14; BEVs, -1.97; PHEVs, -2.10; and FCEVs, -2.28) and the 75th quartile score for PHEVs, BEVs, and FCEVs varies from -1.77 (BEVs) to -2.73 (FCEVs). In short, more than three-fourths of this sample of CA new car buyers has *no* driving experience with PEVs or FCEVs. This result holds for the total sample, too.

Prior awareness of alternative fuel vehicle purchase incentives

- Just less than half (49%) of this sample of CA new-car buyers is aware of incentives from the federal government.
- One-third say they are aware California offers incentives, too.

As stated in the Background, a buyer of any qualifying PEV anywhere in the country is eligible for a federal tax credit. The availability of other incentives varies by state as well as by overlapping city, county, and power utility jurisdictions. As further described in the Background, California buyers of qualifying vehicles are eligible for a Clean Vehicle Rebate and single-occupant vehicle access to high-occupancy vehicle lanes. Additional regional and local incentives may also be available depending location.

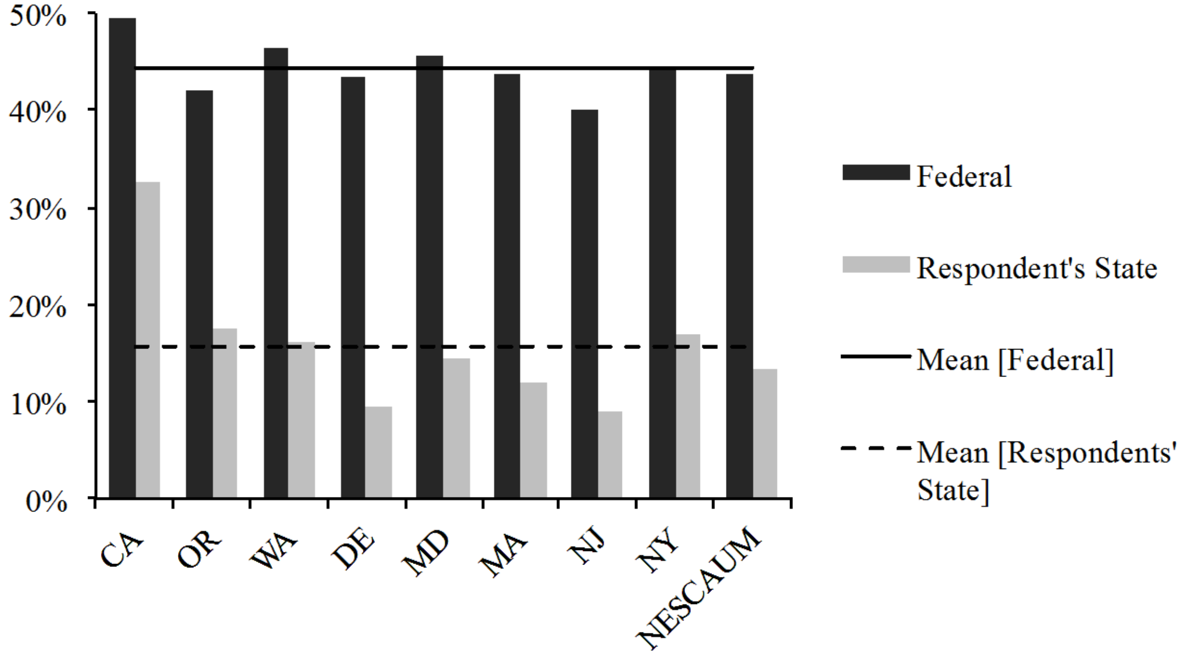
The survey question about awareness of incentives is not specific to presently available incentives but more generally asks, "As far as you are aware, is each of the following offering incentives to consumers to buy and drive vehicles powered by alternatives to gasoline and diesel?" A dozen types of entities are listed; a yes/no/I'm not sure response is elicited for each. If a respondent replies, "Yes," for states, cities, or electric utilities, a follow-up question is asked regarding "my state," "my city," or "my electric utility.[22] The variation in incentives across states and localities means that a respondent replying she or he is aware of incentives from a particular entity is not the same as being right or wrong for all respondent-entity combinations—except for the universally available federal incentive. Data from all participating states regarding reported awareness of federal and state incentives are shown in the Figure 14.

The percent of CA respondents aware of federal incentives (49%) is the highest in any state in the study and well above the average across all states (44%). The same is true for belief their state, California, offers incentives. For the last in particular, the CA respondents are nearly twice as likely as those in any other state (32% CA compared to 17% in OR and NY) to believe their state is offering incentives. Whether 32% is high or low given the Clean Vehicle Rebate program had paid 86,330 rebates totaling ~$181 million to individuals can only be determined in relation to overall programmatic goals.[23] Belief that other entities, e.g., cities, utilities, and manufacturers, offer incentives are comparable to, or lower than, the percentages for respondents' own state.

[22] For the statement "I have heard my state is offering incentives" the responses "Yes" and "No" are not the same as right and wrong for all states. A respondent may live in a state that does not offer any purchase incentives for vehicles powered by alternatives to gasoline and diesel. In such states, "No" is the right answer. This extends to cities, electric utilities, and all the other listed entities. However, for CA respondents, the right answer to whether the "federal government," "states," and "my state" offer such incentives is, "Yes."

[23] Figures are cumulative from the first recorded rebate payment on 18 March 2010 to the closing date of the on-line survey for this study, 6 January 2015. If rebates paid to businesses, governments, and non-profits are included for this interval, the totals are 89,800 rebates totaling ~$189 million. https://cleanvehiclerebate.org/rebate-statistics

Figure 14: Awareness of incentives to buy and drive vehicles powered by alternatives to gasoline and diesel? [Federal government, respondent's state], % "Yes"

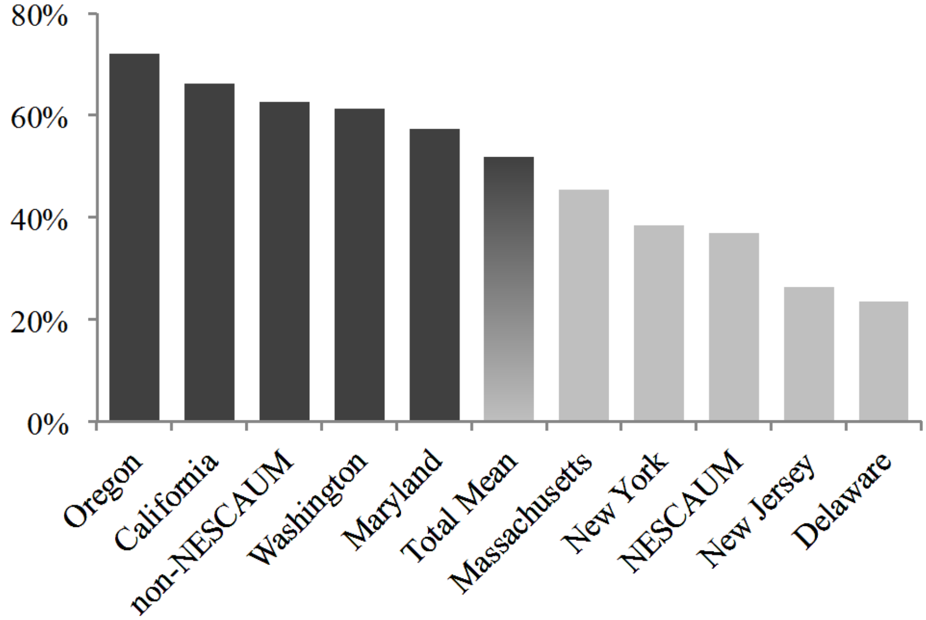


Prior awareness of PEV charging infrastructure

- The CA sample has among the highest percentage of respondents claiming to have seen EVSEs in the parking facilities they use: 66%.

The deployment of PEV charging infrastructure at workplaces (where such charging may or may not be open and available to non-employees), retail locations, and public parking garages, lots, and spots is intended to provide charging services to PEV drivers and to provide a visible symbol to all drivers of PEVs. The question is: are drivers of non-PEVs noticing? Respondents were asked, "Have you seen any electric vehicle charging spots in the parking garages and lots you use?" Data for all participating states (plus the mean value of the total sample, the NESCAUM region, and the aggregate of the participating non-NESCAUM states) are shown in the Figure 15: 66% percent of the California sample say they have seen a PEV charger in the places they park—well above the total sample percentage (52%), though lagging Oregon.

Figure 15: Previously seen charging for PEVs in parking garages and lots, each participating state, the NESCAUM region, and all participating states not in NESCAUM, percent, "Yes"



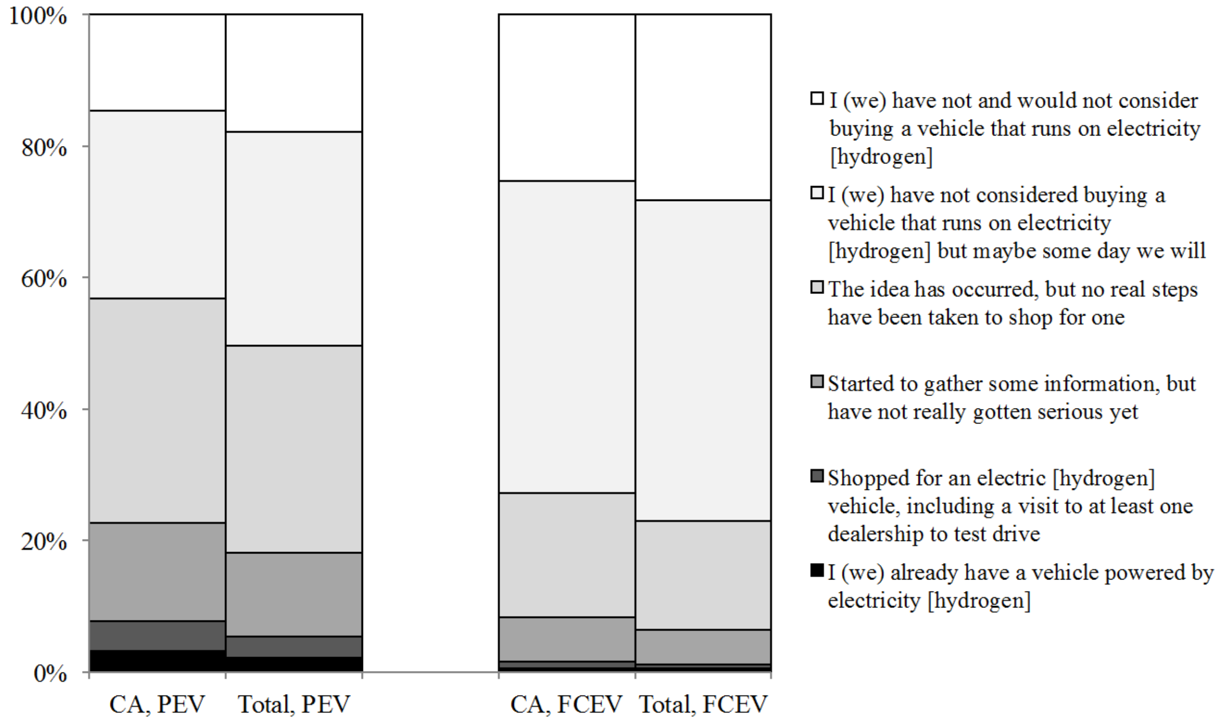
Prior Consideration of the purchase of an BEV or FCEV

The previous sections on BEV name recognition, familiarity with drivetrain types, and experience with HEVs, PEVs, and FCEVs all indicate most new car buyers' awareness and knowledge of PEVs and FCEVs are low. The measure of (prior) consideration was whether they had considered buying vehicles powered by electricity or hydrogen prior to completing the survey. The question for PEVs was:

> "Electric vehicles (BEVs) run only on electricity; they plug-in to charge their batteries. Plug-in hybrid electric vehicles (PHEVs) run on electricity and gasoline; you can both plug them in to charge their batteries and refuel them at a gasoline station. Have you considered buying either of these types of vehicle for your household?"

A similar separate question was asked for FCEVs. Data from both questions are plotted in Figure 16 for the California and total samples. Possible answers are shown as the legend in Figure 16. The California sample was more likely than the total sample to already own, have shopped for, or at least started gathering information about PEVs and FCEVs prior to completing the survey. Both samples plotted in the figure are more likely to have done these things for PEVs than FCEVs. The degree of resistance to ZEVs—"I have not and will not consider a vehicle that runs on electricity [hydrogen]" was lower in CA than for the total sample.

Figure 16: CA and Total Samples, Prior Consideration of PEV or FCEV

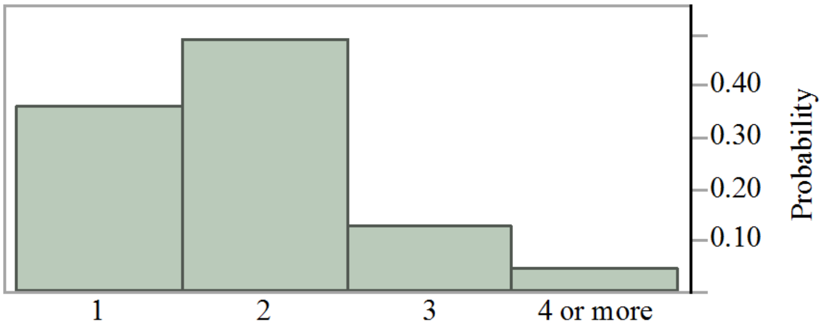


Household Vehicles

- The CA sample owns a similar number of new vehicles, of similar age, as the total sample.
- This sample from California is less likely to have leased vehicles than is the total sample.
- These Californians paid ~$1,000 more, on average, for their most recently acquired new vehicle than did the total sample.

The sample was intended to represent households who acquired a new vehicle within the six years prior to the on-line survey, i.e., since January 2008. The survey instrument collects data on the most recently acquired new vehicle plus the other vehicle in the household (when there was more than one vehicle) that was driven most often. ("Vehicles" were defined in the questionnaire to be "…cars, trucks, vans, minivans, or sport utility vehicles, but…not…motorcycles, recreational vehicles, or motor homes.) Given they must own at least one vehicle to be in the study, 35% of the CA sample owns one and 65% owns two or more. The distribution of number of vehicles owned (Figure 17) is nearly identical to the total sample, as is the number of vehicles acquired as new since 2008. The age distributions of these recently acquired vehicles—measured by the model year or year acquired—are similar for the two samples: the inter-quartile range for both is model year 2010 to 2013. That is, 75% of these new vehicles are model year 2010 or newer and 25% are model year 2013 or newer.

Figure 17: CA Number of Vehicles per household



Frequencies

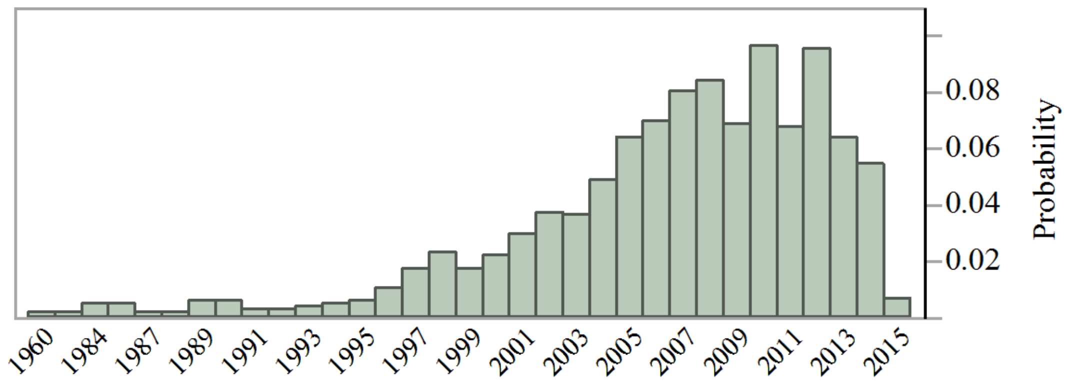
Level	Count	Prob
1	593	0.35488
2	810	0.48474
3	200	0.11969
4 or more	68	0.04069
Total	1671	1.00000
N Missing	0	
4 Levels		

According to data from California's Clean Vehicle Rebate Program, a higher percentage of PEV acquisitions to date have been by lease than purchase compared to non-ZEVs historically and, based on additional survey and interview work with that population of PEV drivers, compared to their own past vehicle acquisitions. Slightly fewer Californians leased their most recently acquired new car (13%), other household vehicle driven most often (8%), or either these vehicles (15%) than did the total sample, for which the corresponding figures are 15%, 9%, and 17%.

On average, the California sample paid more for their most recently acquired new vehicles than did the total sample. The median of the reported "total price including options, fees, and taxes" for the most recently acquired vehicle was $27,500 in CA. This is $1,500 more than for the total sample. The mean price in CA was ~$830 higher than for the total sample ($29,177 compared to $28,346)—a difference that is significant at $\alpha \leq 0.05$. The vast majority of these most recently acquired vehicles (95% in CA and 96% in the total sample) are fueled by gasoline. The balance of recently acquired new vehicles in CA is largely reported to run on diesel or electricity.

For respondents with more than one vehicle, (the second vehicle for which information was collected was the next most frequently driven vehicle), no stipulation was made as to age or whether it was acquired as a new or used vehicle. Thus, these vehicles show a greater age range: the data for the CA sample are shown in Figure 18. Despite the long tail toward older years (note the x-axis is not linear for years older than 1987), 88% of these "second" vehicles are model year 2001 or newer for the CA sample and 90% are so in the total sample. As we don't have data on all vehicles in all households, nor do we ask directly how long households hold their vehicles, we can only suggest the household vehicle fleet may be turning over at a similar rate in CA as in the total sample.

Figure 18: CA Model Year of Other Frequently Driven Household Vehicle

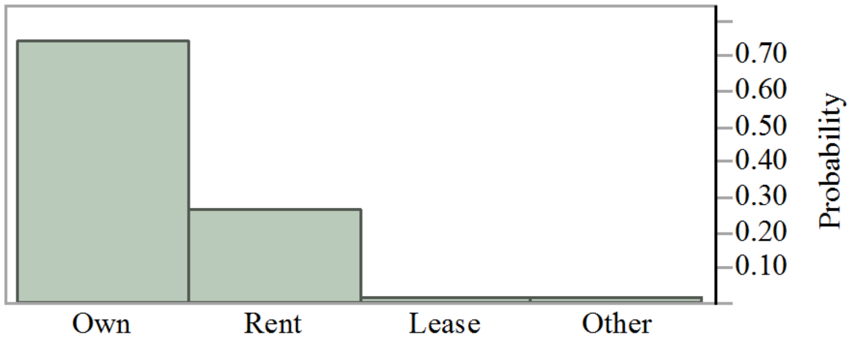


What are the features of their residences, especially those that might affect their valuation of ZEVs?

- The CA sample may be more likely to be able to charge a PEV at home than the total sample.
    - In both samples, similar percentages of respondents own their residence, live in a single family home, have access to electricity at the location they park at least one household vehicle, and do not require permission from someone else to install electricity at their parking location
    - In CA though, a much higher percentage are able to park at least one vehicle in a garage or carport attached to their residence.
- The CA sample reports a higher incidence of solar panels installed at their residence than the total sample, though it remains far less common than not having solar panels installed.
- Based on the much higher reported incidence of residences with natural gas, the possibility for home hydrogen refueling may be higher in CA than in the total sample.

Turning from the household members and their vehicles to features of their residences that may make the respondent households more or less able to charge a PEV or fuel an FCEV at home, most of the CA sample (73%) report they own their home while 26% rent (Figure 19). These percentages are broadly similar to the total sample, though fewer Californians report they own their home and more report they rent. Seven-of-ten California respondents report their residence is a single-family home (similar to the total sample, 72%). A similar percentage of CA respondents report they have no access to electricity at the location they park their vehicles at home (23%) as the total sample (24%). A slightly higher percentage of the California sample (35%) would require permission from someone else to install electricity at his or her home parking location than is the case for the total sample (32%). Despite the slightly lower level of home ownership, far more of the CA sample (71%) reports they are able to park a vehicle in a garage or carport attached to their residence compared to the total sample (56%).

Figure 19: CA Own or rent residence, percent



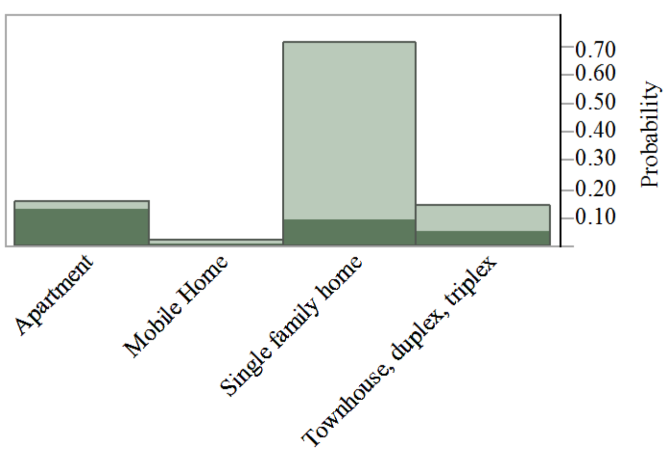
Frequencies

Level	Count	Prob
Own	1224	0.73250
Rent	427	0.25554
Lease	7	0.00419
Other	13	0.00778
Total	1671	1.00000

N Missing 0
4 Levels

The distribution of the building types of residences is shown in Figure 20. Most apartments are rented but only a small share of townhouses, duplexes, and triplexes are. Multi-unit dwellings have been problematic for PEVs, as residents of such buildings may not have access to a regular, reserved parking spot and may be reluctant—or may lack authority—to install electrical infrastructure to charge a PEV. Among those who rent their residence in CA, 76% indicate they could not make such an installation on their own authority; only 21% of those who own their residence indicate they would need permission from someone else. The share of respondents who own a single-family home is somewhat lower than in the total sample: 61% of CA respondents reside in a single-family residence they own compared to 65% of the total sample.

Figure 20: CA Type of Residence, percent



Frequencies

Level	Count	Prob
Apartment	247	0.14782
Mobile Home	22	0.01317
Single family home	1178	0.70497
Townhouse, duplex, triplex	224	0.13405
Total	1671	1.00000

N Missing 0
4 Levels

Note: The darker shade indicates residences that are rented or leased; lighter shading denotes ownership of the residence.

The percentage of CA respondents and the total sample that report they have solar panels installed at their residence is higher than the total sample: 17% compared to 13%. Finally, in CA 76% report having natural gas; much higher than the total sample (63%).[24]

[24] The home hydrogen fueling offered to respondents in the vehicle design games is based on reforming natural gas.

RESULTS: VEHICLE DESIGNS AND INCENTIVES

How many Respondents design their next new vehicle to be a ZEV?

ZEV valuation is assessed in the final design game, which corresponds most closely to present reality. In the final game, ZEVs capable of operating on electricity solely provided by batteries are not available in full-size body styles, and federal, state, and local incentives are offered. The vehicle designs disallowed by the body size restriction are BEVs and PHEVs that run solely on electricity until their batteries depleted to their design minimum state of charge. Both FCEVs and those PHEV designs that run on both gasoline and electricity until the battery is depleted to its design minimum (blended plug-in hybrids) are allowed as full-size vehicles.

Ignoring differences within each drivetrain type, e.g., ignoring differences in driving ranges and charging/fueling speeds across the PEV and FCEV designs created by respondents, 38% of CA respondents design their next new vehicle to be a PEV or FCEV (Figure 21): PHEV (21.5%), BEV (11.0%), or FCEV (5.6%). HEVs are the most common drivetrain design, (34.4%), far greater than the prevalence of HEVs in the actual on-road fleet of vehicles and in new vehicle sales. As illustrated in Figure 21, the distribution of drivetrain types created by the CA sample differs from that of the total sample: broadly speaking, the CA sample is more likely to design their next new vehicle to be a PEV or FCEV. The differences between the CA and total distributions are statistically significant at $\alpha \leq 0.0001$.

The change in distributions of vehicle drivetrain types between Game 1 (all body styles allowed for all drivetrain types, but no incentives) and Game 3 (no full-size body styles allowed with all-electric power supplied solely by batteries, plus incentives) in California is an increase in the percentage of PHEVs, BEVs and FCEVs from 34% to 38%; the increases are due to higher percentages of PHEVs and FCEVs. Transitions of drivetrain types between California respondents' Game 1 and 3 designs are shown in Table 10. The large counts and row percentages along the diagonal (from upper-left to lower-right) correspond to unchanged drivetrain types. Respondents generally stayed with the same drivetrain: 74% of respondents designed a vehicle with the same type of drivetrain in both games. The drivetrain type that loses share among California respondents (and the total sample as shown in Figure 21) going from Game 1 to Game 3 is HEVs. The percent of people who transition from an HEV in Game 1 to a PHEV in Game 3 (~16.5% of people who designed an HEV in Game 1 design a PHEV in Game 3) is the largest row percentage in the table: the decline in the number of HEV designs in Game 3 is explained mostly by the movement of people from HEVs in Game 1 to PHEVs in Game 3. The rise in the prevalence of PHEV designs in Game 3 is also due to respondents shifting from FCEVs in Game 1 to PHEVs in Game 3 (~14.7%) and from BEVs to PHEVs (~12.6%). Despite the transition of some respondents from FCEVs to PHEVs, the movement to FCEVs from other drivetrain types results in the largest percent increase of any drivetrain type between Game 1 and Game 3 (FCEV designs increase by 37%).

Figure 21: CA and Total Sample Vehicle Drivetrain Design Distributions in Games 1 and 3, percent

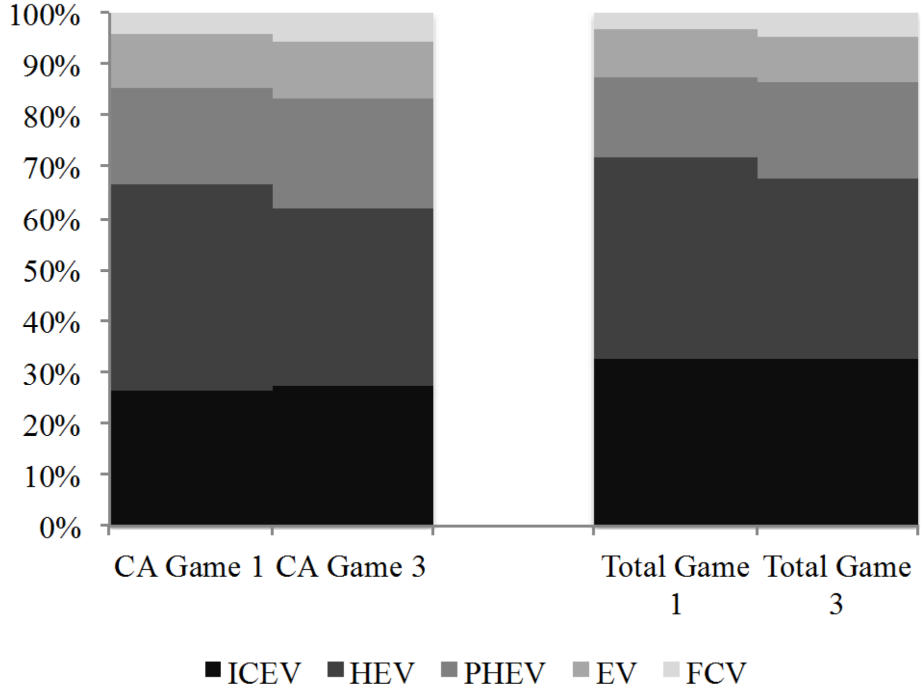


Table 10 CA Game 1 drivetrain design By Game 3 drivetrain design

		Game 3					
	Count Row %	ICEV	HEV	PHEV	BEV	FCEV	Total
Game 1	ICEV	379 85.75	40 9.05	15 3.39	5 1.13	3 0.68	442
	HEV	47 7.04	481 72.01	110 16.47	22 3.29	8 1.20	668
	PHEV	19 6.11	39 12.54	199 63.99	32 10.29	22 7.07	311
	BEV	9 5.14	7 4.00	22 12.57	122 69.71	15 8.57	175
	FCEV	5 7.35	5 7.35	10 14.71	3 4.41	45 66.18	68
	Total	459	572	356	184	93	1664

Characteristics of Respondents' PHEV, BEV, and FCEV Designs

- PHEV designs were by far the most popular of PEV and FCEV possibilities: of 635 respondents who designed PHEV, BEV, or FCEV in the third game, 358 designed a PHEV, 184 a BEV, and 93 a FCEV.

The distributions of these designs are described here. As in the previous section, this discussion details the results of the final game in which no full-size vehicle may be designed with all-electric operation but incentives are offered for PEVs and FCEVs.

PHEVs may differ in how they use electricity stored from the grid (known as "charge-depleting" operation) and their charge-depleting driving range before reverting to operate as conventional HEVs do (known as "charge-sustaining" operation). "All-electric" describes charge-depleting operation that does not use the ICE and its fuel at all. A PHEV with all-electric charge-depleting operation requires an electric motor capable of providing all power and torque required to drive the vehicle and a battery capable of providing all the power required for high demand situations, such as hard accelerations and climbing hills. "Assist" refers to PHEV designs in which the ICE may be used to help power the vehicle even while the vehicle is in charge-depleting operation; they do not require as powerful an electric motor or battery. Thus PHEVs designed for "all-electric, charge-depleting operation" are more expensive than those with "assist charge-depleting operation."

For both these types of PHEVs, when the high-voltage battery (where electricity from the grid is stored) reaches some design minimum state-of-charge (SOC), the vehicle reverts to charge-sustaining operation where the ICE provides more of the power for the vehicle and sustains battery state of charge near the design minimum. A PHEV returns to charge-depleting operation, i.e., powered solely or mostly by electricity from the grid, only after the vehicle is plugged in to recharge the high-voltage battery.

In addition to all-electric or assist charge depleting operation, respondents choose:

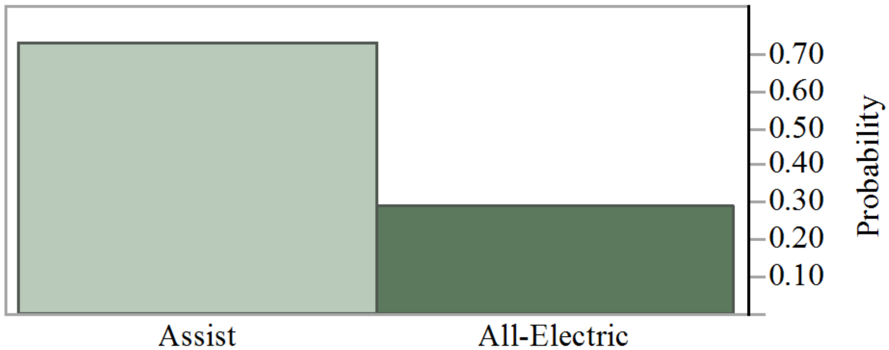
- The driving range over which charge depleting operation lasts;
- The time it takes to fully charge their PHEV design at home (expressed to them in hours); and,
- Whether they want the vehicle equipped to access a limited network of away-from-home quick chargers capable of charging vehicles far more rapidly than can be done at home.

CA Respondents' PHEV Designs

- PHEV designs emphasized longer-range charge-depleting operation.
- The designs are more likely to be assist charge-depleting operation (such as the Prius Plug-in) rather than all-electric (such as the BMW i3 with range extender).
- Fast charging at home or at an initially limited network of quick chargers is not selected by most who design a PHEV.
    - 26% of those who design a PHEV select the fastest charging offered at home, and 40% incorporate quick-charging capability away from home.

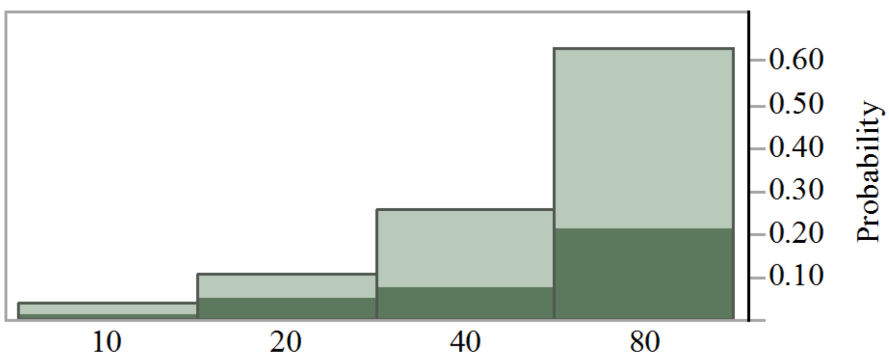
Figures 22, 23, and 24 illustrate the distributions of PHEV designs by charge-depleting modes, charge-depleting driving range, and home charging speed. Most (72%) of the CA sample designed a PHEV with assist all-electric operation (Figure 22).[25] A majority (62%) of the CA sample designed a PHEV with the maximum offered charge-depleting range (Figure 23). Eighty miles is approximately twice the charge-depleting range of the 2014 Chevrolet Volt, though it approximates that offered by BMW's i3 with Range Extender. At the low end, 10 miles approximates the charge-depleting range of the 2014 Toyota Plug-in Prius.

Figure 22: PHEV Charge-depleting operation, n =358



Note: The dark-shaded regions highlight PHEV designs that include all-electric charge-depleting operation.

Figure 23: PHEV Charge-depleting driving range (miles) by all-electric vs. assist mode



Note: The dark-shaded regions highlight PHEV designs that include all-electric charge-depleting operation.

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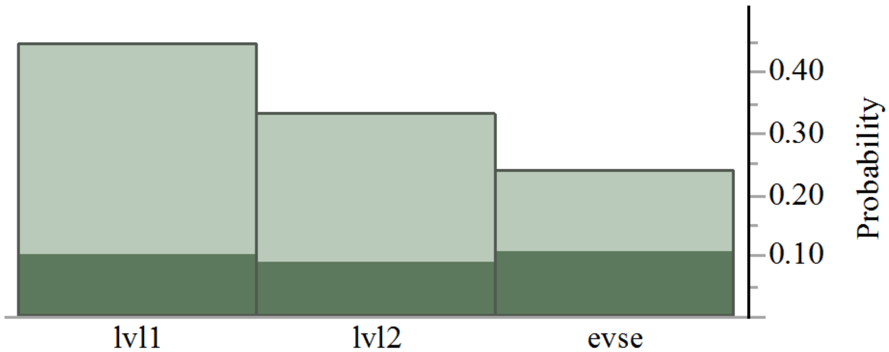
[25] Feedback during the follow-up interviews in California, Oregon, and Washington suggests the concepts of charge-depleting and charge-sustaining operation as well as all-electric vs. assist modes caused considerable confusion. Much of the confusion crosses from HEVs to PHEVs to BEVs; many respondents are confused about the distinctions between these three drivetrains.

Labels for home charging power in Figure 24 are 1.1kW (lvl1), 3.3kW (lvl2), and 6.6kW (evse). Though again, these were presented to respondents in terms of the time it would take to charge a vehicle with the battery that corresponds to their vehicle size, charge-depleting design, and range.

Figure 24: PHEV Home charging power by all-electric vs. assist mode



Note: The dark-shaded regions highlight PHEV designs that include all-electric charge-depleting operation.

The capability to quick charge at a network of stations was presented as requiring the inclusion of an optional plug on the vehicle (mimicking the decision buyers of several PEVs have faced). The cost was presented as $500; charging time was stipulated to be 30 minutes. Respondents were given this description of what to expect of a quick charging network:

> "At first, there will only be a few places you can quick charge. Imagine there is one location you can use to accomplish your day-to-day local travel. It is not the most convenient location—it requires you to go a little bit out of your way. Out of town trips may or may not be possible. Imagine that for at least a couple years, there will be some out of town trips during which you can quick charge, and some that you can't."

Given this, 146 of the 358 (41%) Californians who designed a PHEV incorporated quick charge capability into their vehicle design. There is no difference in the choice of charge-depleting mode or driving range between those who selected quick charging and those who did not. However, there is a difference in the home charging speed: most of those who opt for Level I (70%) or Level II (53%) charging at home do not choose quick charging while most of those who opt for the fastest home charging (EVSE, 53%) do choose quick charging. Still, the sub-set of PHEV designs that incorporates both an EVSE and quick charging (13%) is much smaller than the sub-set that opts for Level 1 home charging and no quick charging (31%).

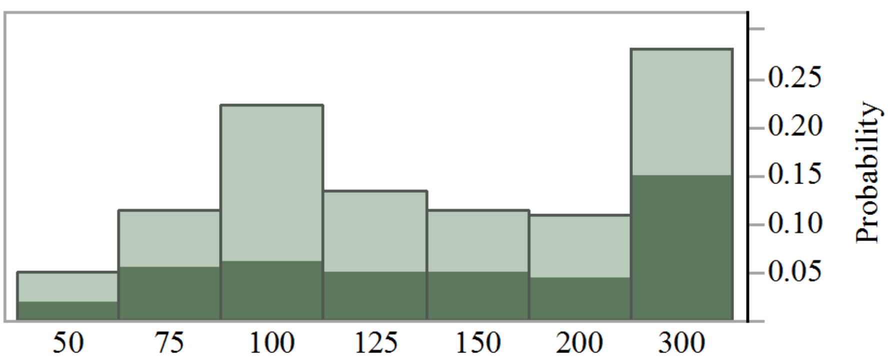
CA Respondents' BEV Designs

- BEV designs incorporate driving ranges from across the spectrum of options, i.e., 50 to 300 miles; just more than half (51%) design BEVs with ranges of 125 miles or less.
  - The distribution of range is bi-modal with peaks at both 100 (22%) and 300 (28%) miles.
- The distribution of home charging speeds is nearly uniform from slowest to fastest.

- Two-thirds of those who design an BEV believe they would be satisfied with a charging speed that could be supplied by existing home 110V (36%) or 220V circuits (31%).
- Less than half (43.5%) incorporate quick charging capability.

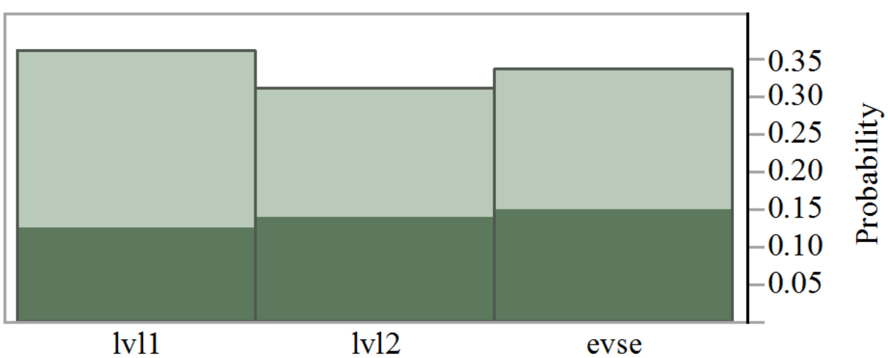
For BEV designs, respondents could manipulate driving range, home recharge times, and whether their vehicle could quick-charging away from home. Driving range options were 50, 75, 100, 125, 150, 200, and 300 miles. Home charging and away-from-home quick charging are as described above for PHEVs except that the away-from-home quick-charging duration for BEVs was stipulated to take longer: one hour for BEVs. The distributions of BEV designs on driving range and home recharging duration are shown in Figures 25 and 26. Just over half the BEV designs incorporate ranges less than or equal to 125 miles. Though it appears in Figure 25 that those whose BEV range is 300 miles are more likely to incorporate quick charging (and those whose range is 100 miles, less likely) the differences are not statistically significant. Neither are the differences in quick charging by home charging duration.

Figure 25: BEV Range by whether quick charging capability was included, n = 184



Note: The dark shaded areas indicate those who also opted for their vehicle to be capable of quick-charging.

Figure 26: BEV Home Charging Duration by quick charging capability



Note: The dark shaded areas indicate those who also opted for their vehicle to be capable of quick-charging.

Taken all together, the BEV designs span the full variety of possibilities. Some respondents design BEVs with "lower" capabilities, i.e., shorter ranges, longer home recharge times and no access to away-from-home quick charging—and the lowest purchase price; some design vehicles with the longest range, fastest home charging, and access to quick charging—and the highest purchase price; and most every other possibility in between appeals to someone.

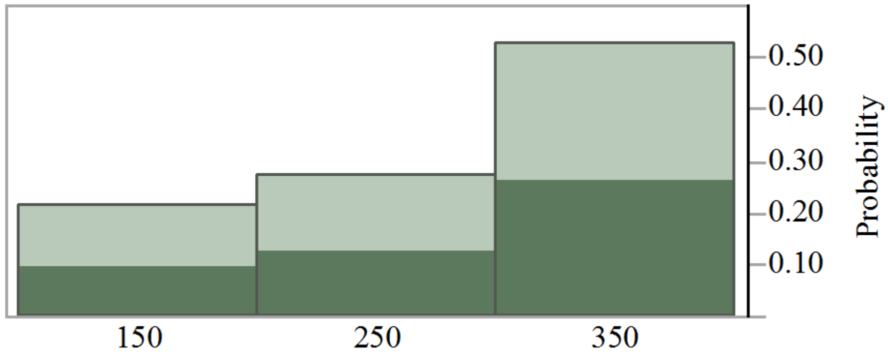
FCEV Designs

- Range includes three possibilities: 150, 250, and 350 miles; over half opt for the longest.
- Home H_2 refueling was included in 45% of FCEV designs.
- There is no difference across driving range options in the likeliness respondents included home refueling.

Respondents could manipulate driving range (150, 250, or 350 miles) and whether they could refuel with hydrogen at home. Results are shown in Figure 27. Home hydrogen refueling was offered at a price of $7,500. This is how away-from-home refueling for FCEVs was described:

> "5 to 15 minutes to fill tank at a service station. Longer driving range options will take a little longer.
>
> "At first, there will only be a few places you can refuel with hydrogen. Imagine there is one hydrogen station that you can use to accomplish your day-to-day local travel. It is not the most convenient location—it requires you to go a little bit out of your way. Out-of-town trips may or may not be possible. Imagine that for at least a couple years, there will be some out of town trips you can't make in your hydrogen fuel cell vehicle."

Figure 27: Distribution of FCEV driving range by home H_2 fueling, n = 93



Note: The dark shaded area indicates respondents who included home H_2 refueling.

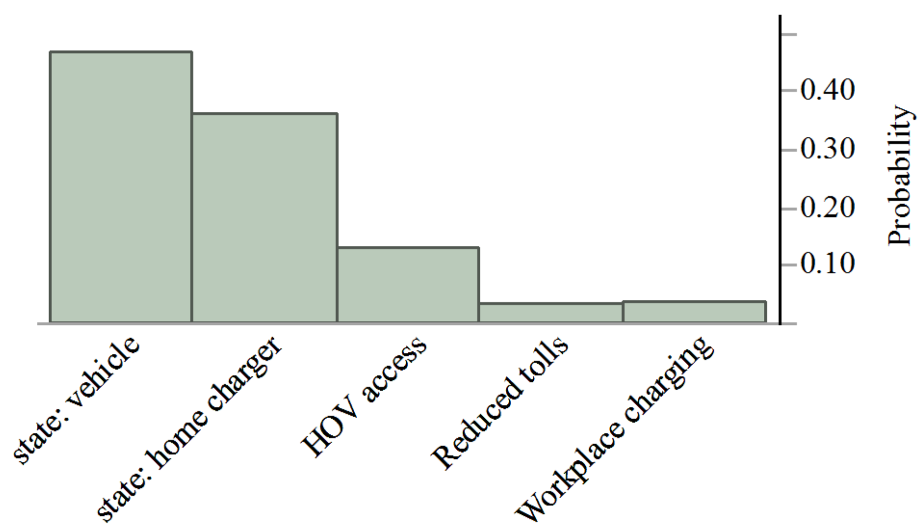
What Incentives do People Choose?

- Given an amount equivalent to the present federal tax credit for their vehicle design, additional financial incentives were selected by a large majority of respondents (82%).
    - The converse of the main result is that one-in-five respondents opted for a use incentive such as HOV access, reduced tolls, or workplace charging.
        - One out of eight CA respondents chose HOV lane access.
- Despite the dollar value of the vehicle and charger incentives being identical, among those who choose a direct financial incentive, they split about four-to-three as to whether they want an incentive for the purchase of the vehicle or home charging/fueling.

In the final game, PHEVs, BEVs, and FCEVs are eligible for federal tax credit (keeping in mind that full-size vehicles are not offered as BEVs or PHEVs that operate in all-electric mode). The amounts offered are customized for each design based on the present federal schedule. In addition, designers of qualifying vehicles choose only one of the following:

- A state vehicle purchase incentive equal to CA's CVR schedule at the time of the survey.
- A state home PEV charger or H_2 fueling appliance purchase incentive. PEV charger incentive equal to the state purchase vehicle incentive above; the H_2 fueling appliance incentive was $7,500.)
- Single occupant vehicle access to high-occupancy vehicle (HOV) lanes (until Jan. 2019)
- Reduced bridge and road tolls (until Jan. 2019)
- If workplace charging isn't already available, imagine it is (not offered for FCEVs)

Figure 28: CA Incentives selected in addition to a federal tax credit, percent



RESULTS: MODELING RESPONDENT VALUATION OF ZEVS

Who designs their next new vehicle to be a PHEV, BEV, or FCEV?

For each respondent's combination of values of explanatory variables, a nominal logistic regression model estimates a probability they produce a design of each drivetrain type. The model assigns the drivetrain with the highest estimated probability as that respondent's predicted design. The variables present in the model to explain who does and does not design their next new vehicle to be a PHEV, BEV, or FCEV are:[26]

- Respondent (and their household) Socio-economic and Demographics
  - None
- Household vehicles, travel, and residences
  - PEV charging access (level of electrical service) at home parking location
  - Home natural gas
- Attitudes related to policy goals: energy supply and security, air quality, and global warming/climate change
  - Environment Component 1: strength of agreement air pollution is 1) a regional threat and 2) a personal risk.
- Prior ZEV evaluation and experience, as well as ZEV-specific attitudes
  - Prior belief electricity is a likely replacement for gasoline and diesel
  - Prior belief hydrogen is a likely replacement for gasoline and diesel
  - Personal interest in ZEV technology
  - Government should offer incentives to consumers to buy vehicles powered by electricity and/or hydrogen
  - Seen PEV Charging in the (non-residential) parking facilities they use
  - Familiarity Component 1: Respondent rating of their familiarity with HEVs, PHEVs, BEVs, and FCEVs
  - Familiarity Component 2: Respondent rating of their familiarity with ICEVs
  - Prior BEV Component 1: relative reliability and safety of BEVs compared to gasoline vehicles
  - Prior BEV Component 2: assessment of driving range and charging time of BEVs
  - Prior FCEV Component 2: assessment of driving range and charging time of FCEVs
  - Driving Experience Component 1: experience driving PHEV, BEV, or FCEV
  - Driving Experience Component 2: experience driving HEV
  - Whether they have already considered buying an BEV
  - Whether they have already considered buying an FCEV

The general effect of each of these variables is described first before moving to an assessment of how influential each variable is in the model of drivetrain designs and the overall performance of the model.

[26] The set of all possible explanatory variables that was evaluated for inclusion in the model is summarized in Appendix A.

Household vehicles, travel, and residence

Home energy infrastructure: electricity and natural gas

- The availability of electricity at the home parking location and natural gas service to their residence are associated with a higher probability of designing a PEV or FCEV.

The only measures of households' existing vehicles, their use or spending on those vehicles, or their residences that appear in the multivariate model of their drivetrain designs from the third game are related to home energy: the availability of electricity where they park their vehicles and whether their home has natural gas. The question about electrical service does refer directly to where the household parks vehicles at home: "Given where you park at home, could you reliably access any of the following to bring electricity to your vehicle?" What follows is this list of possible answers: none, 110V, 220V, an EVSE, or "I don't know." Pictures accompany the first three options. The question about natural gas is not specific as to whether it is available near where vehicles are parked.

In general, the availability of electricity at the home parking location is associated with a higher likeliness of designing a PEV than no access and the higher the power electrical power available, the higher the probability the model estimates for a PEV design. Further, respondents who reside in homes served with natural gas are more likely to design PEVs or FCEVs than those without home natural gas.

Attitudes toward pro-social goals

- Of the three pro-social goals assessed in the survey—energy supply and security, air quality, and global warming/climate change—only attitudes regarding air quality are associated with differences in drivetrain designs.
    - Stronger agreement that air pollution is a regional threat and a personal worry are associated with a lower likeliness to design an ICEV.

A principal components analysis was conducted on seven questions pertaining to the policy goals of energy supply and security, air quality, and global warming/climate change as well as respondents' assessment of whether electricity represents higher or lower environmental and health risks than gasoline in their region. Results indicate respondents' answers to these seven questions can be reduced to three components incorporating five of the original questions:

1) Whether the respondent strongly disagrees (-3) to strongly agrees (3) air pollution is a threat in the region they live *and* they personally worry about it;
2) Whether electricity poses lesser (-3) to greater (3) environmental *and* human health risks vs. gasoline where the respondent lives;
3) Whether the respondent strongly disagrees (-3) to strongly agrees (3) individual lifestyle affects climate change.

Two of the original seven items are not strongly associated with any of the three components: one measures disagreement/agreement that air pollution is affected by individual lifestyle and the other disagreement/agreement with whether there is evidence for rising average global temperatures. These questions were tested individually for inclusion in the model; ultimately, they were not included.

Worry about air pollution

Of the three components of attitudes toward pro-social goals, only the one pertaining to the regional threat and personal worry about air pollution is retained in the model. Higher scores on this component are associated with those who more strongly agree they worry about air pollution and that air pollution is a health threat in their region. Higher scores are correlated with a declining probability to design an ICEV and increasing probabilities of designing any other drivetrain type.

ZEV evaluations prior to the design games and ZEV-specific attitudes

- The following are associated with a higher likeliness the respondent designed a PEV or FCEV:
  - Belief electricity or hydrogen are likely replacements for gasoline and diesel;
  - Personal interest in ZEV technology;
  - Belief governments should incentivize electricity (higher probability of a PEV) or hydrogen (higher probability of an FCEV);
    - Belief that both should be incentivized has less of an effect on increasing the probability of either a PEV or FCEV; belief both should be incentivized had about the same effect as not knowing whether either should be incentivized;
  - Have seen PEV charging in the parking facilities they use;
  - Higher self-ratings of familiarity with all types of vehicles;
  - Stronger agreement PEVs are safer and more reliable than ICEVs;
  - Stronger disagreement the driving range of PEVs is not long enough and charging/fueling times of PEVs and FCEVs are too long;
  - Increased driving experience with HEVs, PHEVs, BEVs, or FCEVs; and,
  - Having—prior to the survey—considered acquiring a PEV or FCEV, at least to the extent they have started to search for information.

Most variables in the model have to do with ZEV-specific beliefs, attitudes, evaluations, and experiences: fourteen variables are related to respondents' consideration of ZEVs prior to completing the design games in the survey. To streamline the discussion, they will be treated in groups depending on their specific meaning.

Prior belief regarding likely replacements for gasoline and diesel

Respondents were asked: "If for any reason we could no longer use gasoline and diesel to fuel our vehicles, what do you think would likely replace them?" They were provided with a list of possibilities (the order in which these were presented was randomized across respondents).

Those respondents who choose electricity or hydrogen as likely replacements for gasoline and diesel are estimated to be less likely to design their next new vehicle as an ICEV. The drivetrain type estimated to increase appears to coincide with the replacement fuel: those who choose electricity are estimated to be more likely to design a BEV and those who choose hydrogen, an

FCEV. However, the increase in neither case is enough to overcome the ancillary increases in the probability the respondent designs an HEV.

Personal interest in ZEV technology

Respondents were asked, "How interested are you personally in the technical details of vehicles that run on electricity or hydrogen and how they work?" Answers were provided on a scale of four discrete points ranging from very interested to not interested. In general, higher personal interest in ZEV technology is associated with a higher likeliness to design a BEV or FCEV. The effect does not appear to be the same for both drivetrains. The highest level of ZEV technology interest appears to favor FCEVs more than BEVs; the next level down of interest appears to favor BEVs more than FCEVs.

Should government offer incentives to consumers to buy vehicles powered by electricity and/or hydrogen

Two different measures were taken of respondents' views of the role of government in providing incentives for alternatives to gasoline and diesel. One asked whether the government should offer incentives to consumers for vehicles that run on electricity or hydrogen. The answers allowed them to decline incentives for both, support incentives for one but not the other, support incentives for both, or declare they did not know. The other statement was more related to a one distinction between liberal and conservative politics in the USA: respondents were asked to rate on a scale the strength of their disagreement (-3) to agreement (3) with the statement, "If government would not interfere, the market would provide all the incentive required for automobile makers to sell cars and trucks that get their energy from electricity and hydrogen."[27]

Of the two measures, the first measure addressing incentives for electricity and hydrogen enters the model. The effects are specific to the fuels, that is, those who think only electricity should be incentivized are disproportionately more likely to design BEVs; those who think only hydrogen are disproportionately more likely to design FCEVs. Agreeing that both should be incentivized yields about the same distributions of designs as believing neither should be subsidized or not knowing whether government incentives should be offered for either or both.

Seen Public PEV Charging

Respondents were asked whether they have seen PEV charging in the "parking garages and lots you use." Those who have seen such public PEV charging are a little more likely to design an HEV, slightly more likely to design a PHEV, and much more likely to design an BEV than those who have not. These increases appear to come at the expense of ICEVs; there is no apparent effect on FCEVs.

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[27] Both measures appear to tap into a political dimension as shown by their relationships to political party affiliation. For example, 60% of respondents reporting they feel the strongest affiliation with the Democratic Party support government incentives for both electricity and hydrogen; only 45% of self-identified affiliates of the Republican Party do. (Still, support for government incentives for both is the plurality position among Republican Party-affiliated respondents. Further, 61% of Republican Party affiliates favor incentives for one, the other, or both.)

Familiarity Components: Respondent rating of their familiarity with 1) HEVs, PHEVs, BEVs, and FCEVs, and 2) ICEVs

Respondents' familiarity with ICEVs, HEVs, PHEVS, BEVs, and FCEVs is measured by a similar question for each: "Are you familiar enough with these types of vehicles to make a decision about whether one would be right for your household?" For each, respondents rate their familiarity on a scale from no (-3) to yes (3). A principal components analysis indicates that two components explain much of the variation of the five measures. PHEVs, BEVs, and FCEVs are clearly associated with the first component and ICEVs clearly with the second. HEVs load on both, but more strongly on Component 1 (with PHEVs, BEVs, and FCEVs) than Component 2. Component 1 is a summary of the respondents' self-assessment of whether they are familiar enough with the alternatives to ICEVs and Component 2 their self-assessment of their familiarity with ICEVs.

Higher scores on Component 1, that is, higher self-rated familiarity with HEVs, PEVs, and FCEVs is associated with a declining likeliness to design an HEV and an increasing likeliness to design a BEV. Higher familiarity with conventional vehicles is associated with a sharply declining likeliness of designing an ICEV, a nearly as sharp increase in the probability of designing an HEV, and a smaller increase in the probability of designing an FCEV

Prior PEV Evaluation Components: 1) relative reliability and safety of PEVs compared to gasoline vehicles and 2) driving range and charging time of BEVs

Prior to the design games in the questionnaire, respondents are asked to evaluate seven attributes of PEVs. A principal components analysis of these seven attributes indicates much of the variation within them can be explained by four components.

- Prior BEV Evaluation Component 1 is associated with respondents' evaluation of the relative safety and reliability of PEVs and ICEVs. Higher scores indicate ICEVs are judged to be safer and more reliable.
- Prior BEV Component 2 is associated with respondents' evaluation of whether "It takes too long to charge electric vehicles" and "Electric vehicles do not travel far enough before needing to be charged." Higher scores signal stronger agreement with these statements.
- Prior BEV Component 3 is associated with both home and away-from-home charging. In contrast to all other Prior BEV Components, higher scores are more favorable to PEVs, indicating higher levels of agreement that the respondent would be able to charge a PEV at home and that there are enough other places to charge PEVs.
- Prior BEV Component 4 is associated with the statement "Electric vehicles cost more to buy than gasoline vehicles." Higher scores indicate stronger agreement.

Of these four, Prior BEV Components 1 and 2 are retained in the model. Higher scores (worse relative performance by BEVs) on both components are associated with a higher probability of designing an ICEV or HEV. In the case of Prior BEV Components 2 (driving range and charging time) the rate of decrease in the probability of designing a BEV as scores increase is faster than the rate of decrease for FCEVs. That the other two Prior BEV Components are not significant explanatory variables does not mean there is no variation in respondents' assessments of charging locations and purchase price, but that those variations are not as strongly correlated with differences in respondents' drivetrain designs as are safety, reliability, driving range, and charging time.

Prior FCEV Evaluation Component 1: assessment of driving range and charging time of FCEVs

Respondents also evaluated FCEVs on several dimensions prior to their design games. In the case of FCEVs, three components explain much of the variation in six attributes of FCEVs:

- Prior FCEV Component 1 is associated with the relative safety and reliability of FCEVs compared to ICEVs; higher scores indicate ICEVs are safer and more reliable.
- Prior FCEV Component 2 is associated with assessments whether FCEV driving range is too short and fueling times too long. Higher scores indicate stronger agreement ranges are too short and fueling times too long.
- Prior FCEV Component 3 is associated with the assessments whether there is a sufficient network of hydrogen fueling stations; higher scores indicate stronger agreement "There are enough places for drivers to refuel their cars and trucks with hydrogen."

Of these three components, only Prior FCEV Components 2 (range and fueling time) is retained in the model. Higher agreement that FCEV driving range is too short and fueling takes too long is associated with a higher likeliness of designing HEVs, PHEVs, and BEVs at the expense of ICEVs and FCEVs.

The measure of whether FCEVs cost more than gasoline vehicles was not associated with any component. Attempting to enter this variable directly (along with the other components) does not pass the tests for improving the overall model or significance of this individual variable.

Driving Experience Components: 1) PHEV, BEV, or FCEV, and 2) HEV

Respondents rated the extent of their driving experience from "none at all" (-3) to "extensive" (3) with each of these four types of vehicles: HEVs, PHEVs, BEVs, and FCEVs. A principal components indicates the four measures can be represented by two components: Driving Experience Components 1 summarizes self-ratings of the amount of driving experience with PHEVs, BEVs, and FCEVs and; Driving Experience Components 2 is primarily a measure of driving experience with HEVs.

Both Driving Experience Components are retained in the model of respondents' drivetrain choices. They have similar, but subtly different effects. Higher scores on both components are associated with lower probabilities of designing an ICEV. Higher scores on Driving Experience Component 1 (PHEVs, BEVs, and FCEVs) were associated with comparatively slight differences in the probabilities of designing an HEV or PHEV, but are associated with increasing probabilities of designing a BEV or FCEV. Higher scores on Driving Experience Component 2 (HEVs) were associated with higher probabilities of designing HEVs, PHEVs, and BEVs, but not FCEVs.

Whether they have already considered buying an BEV or an FCEV

Also prior to entering their design games, respondents are asked whether they have considered buying a PHEV, BEV, or FCEV for their household. Their answers are on the following scale (with the wording changed from "electricity" to "hydrogen" for FCEVs):

- I (we) have not—and would not—consider buying a vehicle that runs on electricity
- I (we) have not considered buying a vehicle that runs on electricity—but maybe someday we will
- The idea has occurred, but no real steps have been taken to shop for one
- Started to gather some information, but haven't really gotten serious yet
- Shopped for an electric vehicle, including a visit to at least one dealership to test drive
- I (we) already have a vehicle powered by electricity

For analysis, the three levels indicating some active engagement with the idea of acquiring such a vehicle are grouped into a single category: gathered information/shopped/own. This is done because of the comparatively small number of people in these response categories, especially for FCEVs. Thus the scale used in the model is truncated to this:

- I (we) have not—and would not—consider buying a vehicle that runs on electricity
- I (we) have not considered buying a vehicle that runs on electricity—but maybe someday we will
- The idea has occurred, but no real steps have been taken to shop for one
- Started to gather some information; shopped for a PEV; already own a PEV

In general, higher levels of consideration of PEVs and FCEVs are associated with higher probabilities of designing one. Conversely, those comparatively few people who say they "have not and would not consider" a PEV or FCEV apparently mean it: they have very low probabilities of designing one as their household's next new vehicle.

The effects of prior consideration appear to have distinct inflection points. The measure of prior BEV consideration has a sharp inflection point at "I (we) have not considered buying a vehicle that runs on electricity—but maybe someday we will." Above this point, higher levels of consideration are associated with higher probabilities of designing a PEV (primarily at the expense of ICEVs). Below this level, there is comparatively little affect on the probability of designing a PEV, though those who "have not and would not" consider a PEV are less likely to design even an HEV. In the case of FCEVs, the inflection point is one point higher on the scale: "The idea has occurred, but no real steps have been taken…." Only above this point does the probability of designing an FCEV increase much compared to the rest of the scale.

What are the influential explanatory variables?

Table 11 shows a measure of the importance of the explanatory variables to estimating changes in the probability of drivetrain designs. The measures are relative to each other and have no comparison to any absolute scale. The main effect measures the importance of each variable by itself; the total effect adds the additional effect of any interactions with other variables. In this case all the most important variables have only main effects. Though it would barely change its rank order (upward by one place), the additional importance attributed to Environmental

Component 1 (Regional threat and personal risk of air pollution) by accounting for its interaction effects more than doubles its importance score. Familiarity Component 2 (ICEVs) would rank next to last on its main effect alone, but its interaction effects triple its importance score such that it is more important to the estimated probabilities than is Familiarity Component 1 (HEVs, PHEVs, BEVs, FCEVs) and rivals direct driving experience of HEVs (Driving Experience Component 2 (HEVs)).

Table 11 Importance of explanatory variables to drivetrain probability estimates

	Variable Importance	
Explanatory Variable	**Main Effect**	**Total Effect**
Replacement: Electricity	0.095	0.095
Replacement: Hydrogen	0.095	0.095
Highest Home PEV Charging Access	0.095	0.095
Home natural gas	0.095	0.095
Prior Consideration of an BEV	0.095	0.095
Prior Consideration of an FCEV	0.095	0.095
Should government offer incentives	0.095	0.095
Seen Public EVSEs	0.095	0.095
Personal interest in ZEV technology	0.095	0.095
Environment Components1 (Regional and personal AQ)	0.031	0.070
Driving Experience Component 2 (HEVs)	0.022	0.034
Familiarity Component 2 (ICEVs)	0.010	0.029
Prior BEV Component 1 (safety-reliability)	0.021	0.024
Familiarity Component 1 (HEVs, PHEVs, BEVs, FCEVs)	0.022	0.022
Driving Experience Component 1 (PHEVs, BEVs, FCEVs)	0.019	0.019
Prior BEV Component 2 (driving range-charging time)	0.014	0.014
Prior FCEV Component 2 (driving range-fueling time)	0.007	0.007

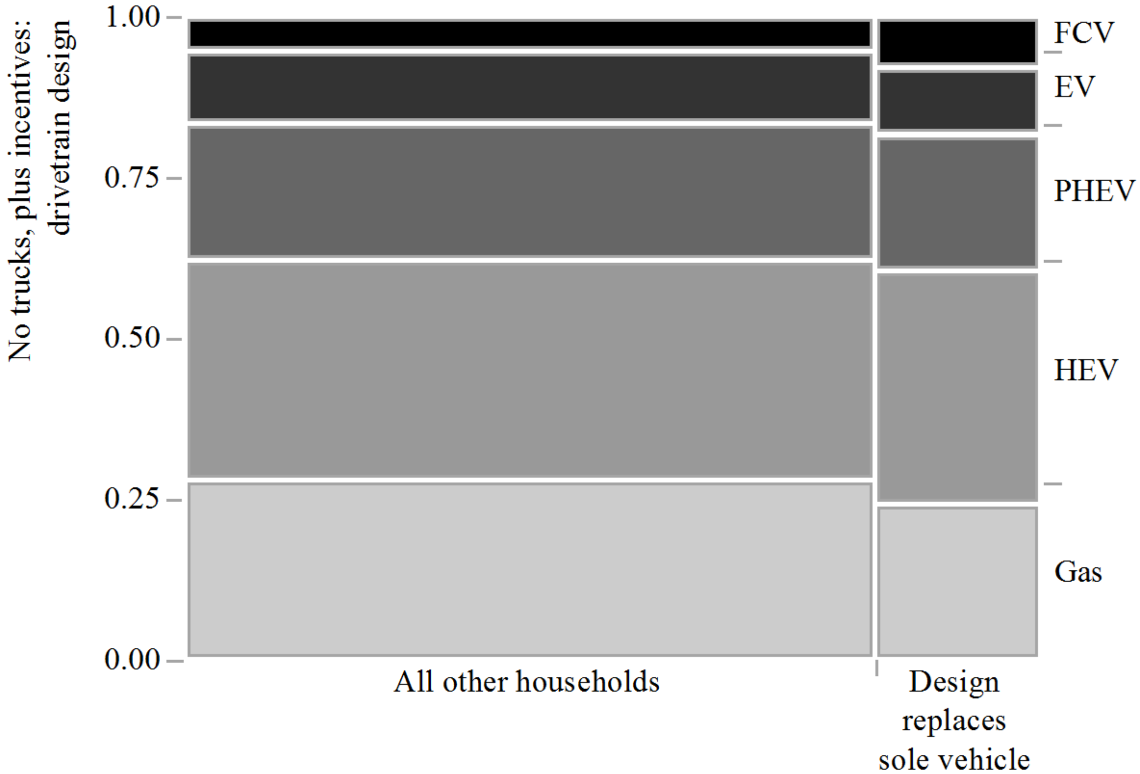
Household's in which their design vehicle will replace their sole vehicle.

Among the variables that are not in the final model of drivetrain designs are those distinguishing households by the number of vehicles they own and the day-to-day flexibility households may have to assign different vehicles to different drivers. The bivariate results reported in Appendix A indicate there is no correlation between drivetrain types in Game 3 and either the total number of household vehicles or the number acquired as new since January 2008; there is correlation to a measure of the flexibility of day-to-day use of household vehicles.

A special case may be those households that own only one vehicle and plan on their next new vehicle replacing their present vehicle, that is, households who are one-vehicle households and expect to remain one-vehicle households. Given that flexibility to switch and swap vehicles within multi-vehicle households may be an important capability to adapt a BEV to a household's travel needs, the question arises whether single vehicle households (who intend to remain single vehicle households) design different vehicles than multi-vehicle households. Of the 1,671 households in the CA sample, 318 (19%) indicate the next new vehicle they acquire will replace their sole vehicle. Drivetrain types from the design games are cross-tabulated by whether the design vehicle is intended to replace a sole household vehicle vs. households who are (or will become) multi-vehicle households. Figure 29 shows the result from the final design game.

While there appears to be slight differences, they are not statistically significant. The results are similar for Game 1. In short, single-vehicle households who expect to remain single-vehicle households even after their next new vehicle acquisition are neither more nor less likely to be initially attracted to PEVs and FCEVs nor to be more nor less influenced by the disallowance of full-size battery-powered electric drive and addition of incentives than are multi-vehicle households.

Figure 29: Drivetrain type by sole household vehicle



N = 1,668 Degrees of Freedom = 4

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	5.799	0.2147
Pearson	6.064	0.1944

RESULTS: POST-DESIGN GAME MOTIVATIONS FOR VEHICLE DESIGNS

After respondents completed their design games they were asked to assess several possible motivations for why they did or did not design a PHEV, BEV, or FCEV. The lists of possible motivations were derived from prior interviews, focus groups, and workshops with PEV drivers and people from similar households who do not drive PEVs. Many motivations were related to questions that had already been asked, e.g., environmental motivations for (and against) vehicles powered by electricity and assessments of PEV and FCEV performance. The motivation questions asked respondents to comment on their specific vehicle design. This analysis of their motivation scores provides a second perspective on the modeling results reported in the previous section.

Why did people design PHEVs, BEVs, or FCEVs?

- Highly rated motivations to design a PHEVs, BEVs, or FCEVs were a mix of private and pro-social:
    - Private: Savings on (fuel) costs, interest in new technology, convenient to charge a PEV at home.
    - Pro-social: Reducing the effects of personal travel on climate change, air pollution, oil imports, and payments to oil producers.
- There was little direct acknowledgement by respondents that incentives offered in the design games were important to their vehicle design.

Motivations for designing PHEVs, BEVs, or FCEVs were assessed on a scale from 0 = not at all important to 5 = very important. Respondents were presented with a list of 17 possible motivations derived from prior research. However, respondents were restricted to spend a maximum of 30 points summed across 17 possible motivations. Because not all respondents spent the maximum number of points, an "average" score for any individual motivation is the total number of points spent by all respondents, divided by the number of respondents, and divided again by the number of possible motivations. The resulting mean motivation score for those who designed a PHEV, BEV, or FCEV in the California sample was 1.38. Any motivation with a mean score higher than this global mean is interpreted as having a "high" score. The possible motivations are listed in Table 12, sorted from high to low by their mean score; the percent of respondents assigning maximum importance, i.e., five points, is shown, too.

Eight motivations have mean scores higher than the global mean (Table 9). The top motivations are a mix of private and pro-social benefits. Forty-one percent of respondents who design a ZEV give the maximum number of possible points (5) to saving money on fuel costs (and two-thirds assign an above average number of two or more points)—possibly revealing a "partial rationality" that apportions costs to different categories and treats them separately from —and possibly even differently than—vehicle purchase costs. The idea that saving money on fuel costs would be an important motivation is not signaled directly by any explanatory variable in the statistical model of the design game results.

Table 12: CA Motivations for Designing a PEV or FCEV, high to low mean score

Motivation	Mean	% 5 pts.
To save money on gasoline or diesel fuel	2.91	41.0
I'm interested in the new technology	2.39	29.8
It will reduce the effect on climate change of my driving	1.87	23.0
It will reduce the effect on air quality of my driving	1.84	20.5
It will reduce the amount of oil imported to the United States	1.55	16.7
I'll pay less money to oil companies or foreign oil producing nations	1.52	17.0
It will be fun to drive	1.49	14.6
It will be safer than gasoline or diesel vehicles	1.47	15.6
Mean motivation score	1.38	
Fueling the vehicle at home will be a convenience	1.35	14.0
It looks good	1.16	11.1
It fits my lifestyle/activities	1.15	9.5
I'll save on the cost of maintenance and upkeep	1.07	8.4
It will be more comfortable	0.95	8.3
The incentives made it too attractive to pass up	0.94	8.7
I'll save on the cost of vehicle purchase	0.86	7.1
I think it makes the right impression for family, friends, and others	0.73	4.3
Another motivation[1]	0.19	2.4

1. Forty-one respondents listed "another" motivation; only 15 gave their alternative the highest score.

The importance of an attraction to ZEV technology—even among these people who are not among the earliest buyers of PEVs—is underscored by the fact this motivation had the second highest mean score. A personal interest in new technology was given the highest possible score by almost 30 percent of those who designed a PEV or FCEV and 55% gave it two or more points. In the multivariate modeling discussed in the previous section, this motivation may have been signaled by whether the respondent had already considered a PEV or an FCEV, familiarity and experience with HEVs, PEVs, and FCEVs for their household prior to completing the survey, or most directly, the measure of respondents' own interest in ZEV technology.

The four motivations related to policy goals of climate change, energy supply and security, and air quality all had mean scores higher than the global mean. However, only those pertaining to air pollution—whether air pollution is believed to be a regional health risk and the respondent is personally worried about air pollution—loaded strongly onto the Environment Components in the statistical model of drivetrain designs.

"Fun to drive" and "safer than gasoline or diesel vehicles" are the last two motivations with average scores above the global mean motivation score. The importance of safety here reiterates its appearance in the statistical model as the component combining respondents' prior evaluation of PEV reliability and safety compared to gasoline and diesel vehicles.

As to the importance of incentives, few people who designed a PEV or FCEV acknowledged that the offered incentives were important to the design of their vehicle in the final game. The mean score for the role of incentives was well below the global mean and only 8.7 percent scored it as high as possible. In the 1st game (no incentives offered, but full-size vehicles with all-electric operation allowed), 556 people designed PHEVs, BEVs, or FCEVs. In the third game (incentives offered, but full-size BEVs and full-size PHEVs with all-electric operation are not allowed), this increased to 635 respondents. This increase in the number of ZEV designs despite no full-size ZEVs would be consistent with a greater importance of incentives on respondents' vehicle designs. Yet even among those who switch from an ICEV or HEV in the first game to a PHEV, BEV, or FCEV in the third game, incentives did not score incentives as an above average motivation (mean = 1.19). As with the case for attitudes toward climate change, and energy security, there is some distinction to be made between the effects inferred from the design games and those expressed in after-the-fact explanations by the respondent of why they did what they did in the design game.

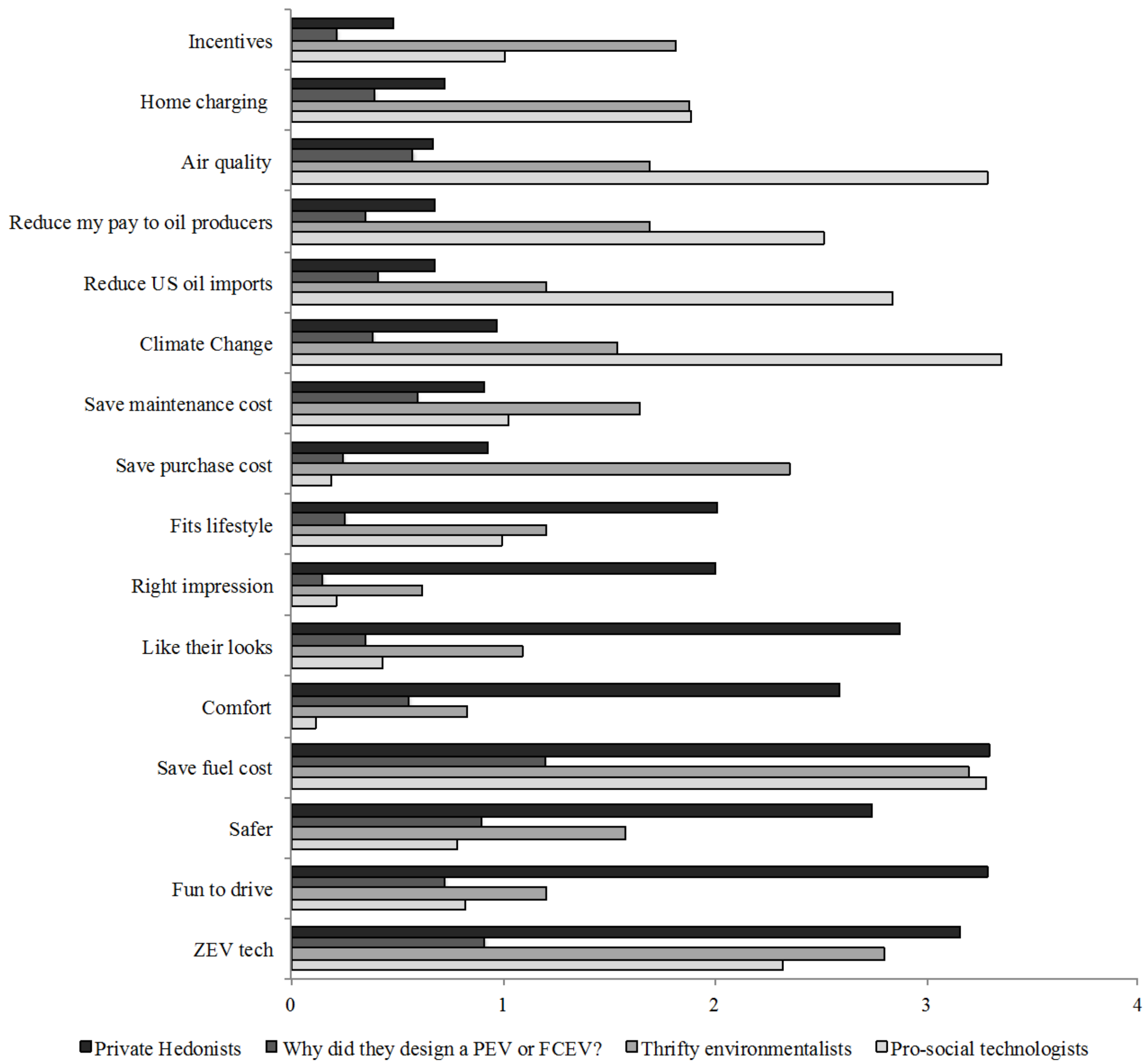
Distinct motivational groups among those who design PEVs or FCEVs

Here, motivations are analyzed to discover whether, and what, groups of people exist based on shared motivations. This extends and refines the explanations of who is interested in ZEVs and why. This search for groups defined by shared patterns of motivations is done by cluster analysis. One output is the mean score for each motivation within each cluster of people who share similar motivations. In Figure 30 the cluster means for a four-cluster solution are plotted. The final stage of cluster analysis rests on the analyst and the reader to decide whether any observed patterns offer interpretable and actionable information; the labels shown in Figure 30 for each cluster are provided as the authors' interpretation. Before reading the authors' rationale below, readers are encouraged to examine Figure 30 and name these groups themselves to test whether they name these clusters differently based on the highly scored motivations they share.

"Pro-social technologists" are pro-social because they rated all pro-social motivations—climate change, energy security and supply, and air quality—above the global mean. Their three other above-average motivations (interest in ZEV technology, convenience of home charging, and save fuel costs) don't form a single meaning; we choose to emphasize technology because it clearly relates to "I'm interested in the new technology" and that new technology incorporates home charging. Also, we'll use fuel cost savings to help distinguish the second cluster from this first one. "Thrifty environmentalists" are distinguished from "pro-social technologists" by their interest in costs (they are the only cluster that scored all the cost motivations above average, including incentives). They scored three of the four pro-social motivations highly. What distinguishes these first two clusters from each other is the relative strength of their motivations;

this is exemplified by the fact the highest pro-social score among the pro-social technologists (3.35 for climate change) just slightly surpasses the "save fuel cost" score (3.30) of the "thrifty environmentalists." In contrast to these two groups, "Private hedonists" score no pro-social issue highly; their high mean motivation scores were to satisfy private desires (fun, comfortable, safe, good looking cars that make the right impression on family and friends)—and save fuel cost. Finally, for the "Why?" cluster, no mean motivation score is larger than global mean score.[28]

Figure 30: CA Mean motivation scores for four clusters of respondents who design PEVs or FCEVs.



[28] This is because they tend to not assign points many points. The first three clusters assign an average of 25 to 28 of a possible 30 points. The "why" cluster assigns an average of only eight points. Given they assign so few points, it is notable that saving fuel costs and interest in ZEV technology have the highest mean scores within this cluster.

Why don't people design PEVs or FCEVs?

- The highest scoring motivations against designing PEVs and FCEVs had to do with their inherent newness:
    - Limited initial charging and fueling networks;
    - High initial purchase price and unknown (but assumed to be high?) operating and maintenance costs;
    - Short driving range (a problem both in and of itself, but also possibly a "1st generation technology" issue);
    - Unfamiliarity with the new technology;
    - Worry about the effects on electricity supply; and the straight-forward,
    - "I'm waiting for the technology to become more reliable."
- Immediate, practical limits on the ability to charge a PEV at home.
- Few acknowledged that greater incentives (of the kind offered in the game) would have changed their minds.

Based on their vehicle designs, more respondents appear to not be interested in PEVs or FCEVs (at least at this point in time). Motivations against designing such vehicles were assessed by a similar process as motivations for designing them. Respondents assigned points on a scale from 0 = not at all important to 5 = very important. There were 19 possible motivations against ZEVs derived from prior research. Respondents were told they could spend up to 30 points but did not have to spend them all. The global mean score for all motivations against PEVs and FCEVs was 0.96. Any item scoring higher than this (rather than higher than 2.5, i.e., the mid-point of the rating scale) is interpreted as having a "high" score.) The possible motivations against designing a ZEV as the next new car are listed in Table 13, sorted from high to low by their mean score.

The mean score assigned to eleven motivations against designing a ZEV were higher than the global mean score (Table 13). Many of the highly scored motivations against designing a PEV or FCEV speak directly to the inherent newness of the vehicles: limited away-from-home fueling, respondent's unfamiliarity with new technology, uncertainty about effects on electricity supply, and waiting for technology to become more reliable. Arguably, other motivations such as the high initial purchase price and distance per charge or fueling also belong to this category of "teething problems of new technology." This is not to dismiss the importance of these concerns in the here and now, but to note that all may improve with each new generation of technology, with continued market growth and infrastructure deployment, and with continued accumulation of experience and information by consumers. Though it is not possible to discern exactly how each respondent construed the measures of "familiarity" and "experience" in the statistical model, it seems likely that some of the uncertainty expressed by the post-design game motivations was about a lack of familiarity and experience with new technology. Of the other variables in the statistical model of Game 3 drivetrain designs, those that most directly relate to highly rated motivations against designing a PEV or FCEV are Prior BEV Component 2 and Prior FCEV Component 2: prior evaluations of driving range and charging/fueling time load highly on these two components.

The interpretation of the (lack of) effect of incentives in the 3rd game is somewhat different than for those respondents who did design a PEV or FCEV. For those who did not, few were willing to state that higher incentives would have changed their minds: the mean score for "higher incentives would have convinced me" is 0.47 and only about four percent assigned this item the maximum number of points. Despite the importance of high vehicle purchase price as a motive against designing a PEV or FCEV, simply offering more money (in the form of vehicle, charger, or home fueling rebates or reduced tolls) or (limited) charging infrastructure (in the form of workplace charging if it doesn't already exist) didn't overcome enough other motivations against.

Table 13: Motivations against Designing a PEV or FCEV, high to low mean score

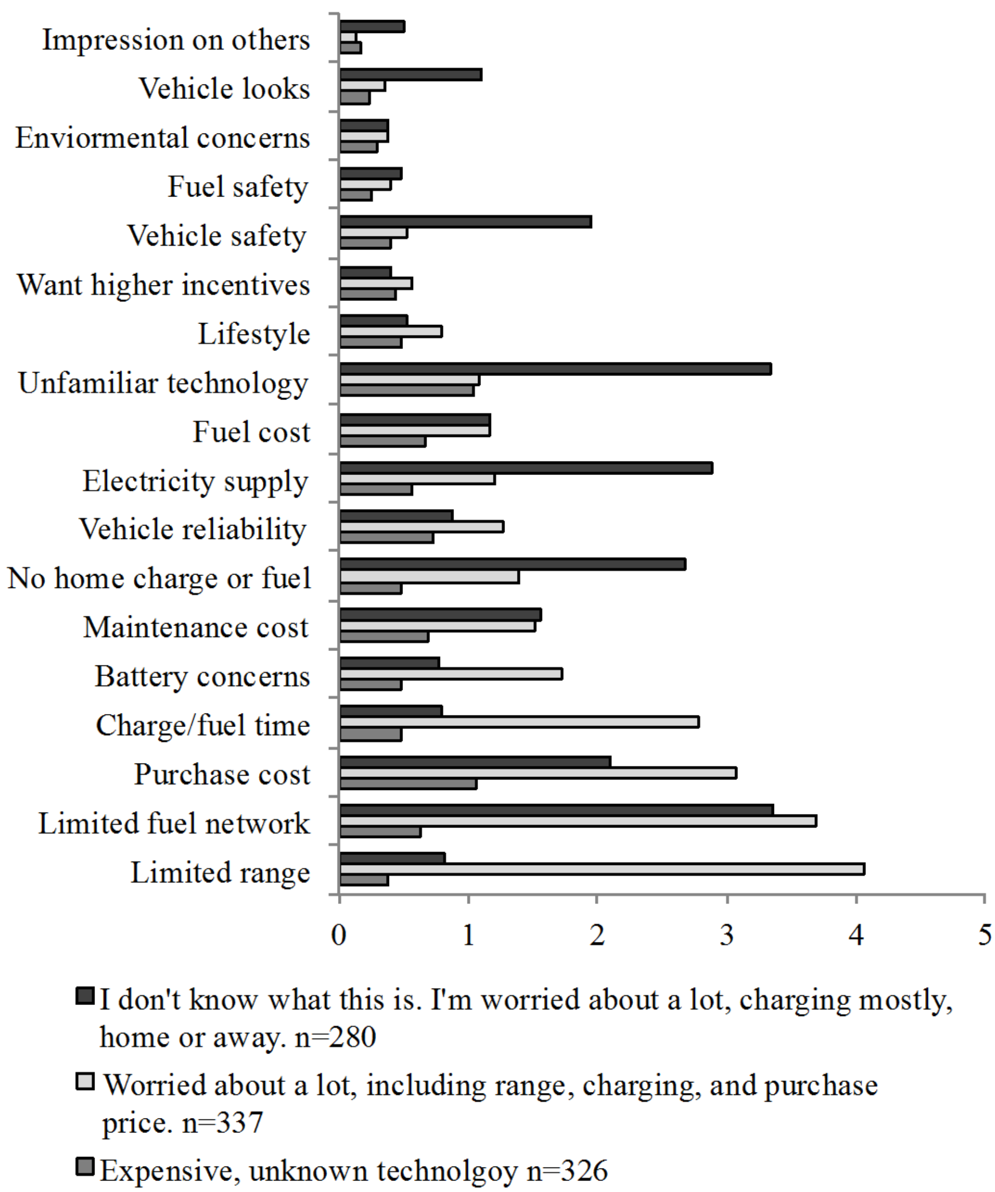
Motivations against designing a PHEV, BEV, or FCEV	Mean	% 5 pts.
Limited number of places to charge or fuel away from home	2.52	37.0
Cost of vehicle purchase	2.08	30.2
Distance on a battery charge or tank of natural gas is too limited	1.82	24.9
I'm unfamiliar with the vehicle technologies	1.73	23.0
Concern about electricity, e.g. blackouts and overall supply	1.48	17.8
Can't charge vehicle with electricity or fuel with hydrogen at home	1.46	20.7
Concern about time needed to charge or fuel vehicle	1.39	16.3
Cost of maintenance and upkeep	1.23	15.0
Concerns about batteries	1.01	10.7
Cost to charge or fuel	0.99	10.4
I'm waiting for technology to become more reliable	0.97	10.4
Mean points per person per item	0.96	
Concern about vehicle safety	0.90	10.4
Doesn't fit my lifestyle/ activities	0.60	6.6
I don't like how they look	0.53	5.4
I was tempted; higher incentives would have convinced me.	0.47	4.2
Concern about safety of electricity or natural gas	0.37	2.9
Environmental concerns	0.35	3.0
I don't think they make the right impression	0.26	1.9
Another motivation	0.16	1.9

1. Only 16 respondents listed an "another" motivation; only six assigned 5 points to their specified motivation.

Distinct motivational groups among those who do not design ZEVs

As was done for the respondents favorably disposed toward ZEVs, here the motivations (or perhaps, concerns) of those who did not design a ZEV are examined. Results of a three-cluster solution are illustrated in Figure 31.

Figure 31: CA Mean motivation scores for three clusters who do not design PEVs or FCEVs.



In contrast to the cluster analysis for those who did design ZEVs, the cluster analysis of the motivations of those who did not is more singular in its conclusion. The primary distinction between clusters is between the first two and the third: both the first two clusters are characterized as "worried about a lot" because their mean scores for half or more of all motivations to not design a ZEV were higher than the global mean. By contrast, the third cluster registered only barely above average concern with "vehicle purchase price and "unfamiliar technology." [29]

The first two clusters account for about two-thirds of the respondents who do not design ZEV. They are characterized by a long list of motivations against—differences between the groups have mostly to do with the details of their lists. One emphasized limited range, limited away-from-home charging/fueling networks, charging/fueling times, and purchase cost concerns. The other was forthright about simply being unfamiliar with the technology. Their concern with limited fueling networks extended to an inability for many to charge or fuel at home. We note that even given the lower level of concern (compared to the first two clusters) for vehicle purchase price and unfamiliarity expressed by the third cluster, these two motivations against designing a ZEV were scored higher than the global mean by all three clusters.[30] In contrast, no cluster scored the item "higher incentives would have convinced me" higher than the global mean.

[29] This low-scoring cluster averages ~9 points spent out of the possible 30, compared to 26 to 27 points for the other two clusters.

[30] It is possible for everyone to "be above average" on three individual motivations and no one to be above average on another (in fact, there are five motivations for which the group average score is not higher than the global average) because the global mean used for comparison is the mean across all motivations.

RESULTS: COMPARISON OF STATE RESULTS

In this section, results from California are compared to those from other the states where the on-line survey was conducted. Multiple geographies are represented in this study. The geography of air quality standards is fairly uniform. All the states except New Hampshire share California's air quality standards because they have exercised their prerogative under Section 177 of the federal Clean Air Act to adopt California's standards. All the states except Delaware, New Hampshire, and Washington have also adopted California's ZEV sales requirements. While NESCAUM is not a policy-making or regulatory body itself, it does serve as a forum for its member states to coordinate information, analysis, and actions across a variety of environmental policy areas. The geography of the market varies between the states and regions as more types of PEVs have been offered for sale for longer in the three western states than in the eastern states. Beyond these, there are many differences in other state policies, e.g., whether states offer incentives for consumer purchase of ZEVs and if so what incentives.

This section compares and contrasts the states and NESCAUM analyses. The intent is to explore at both the general conceptual level and at the level of specific measures within classes of concepts the extent to which the multiple analyses have produced a mutually reinforcing and unifying set of understandings across the multiple policy and market geographies vs. the extent to which there are idiosyncratic findings for individual states or NESCAUM. This discussion starts with the measures of respondents' prior PEV or FCEV consideration. Then, the distributions of drivetrain designs are compared: distributions of vehicle designs; the multivariate models to explore the explanatory variables of those vehicle design distributions; and finally, motivations of both those who did design a PEV or FCEV and those who designed an ICEV or HEV are compared.

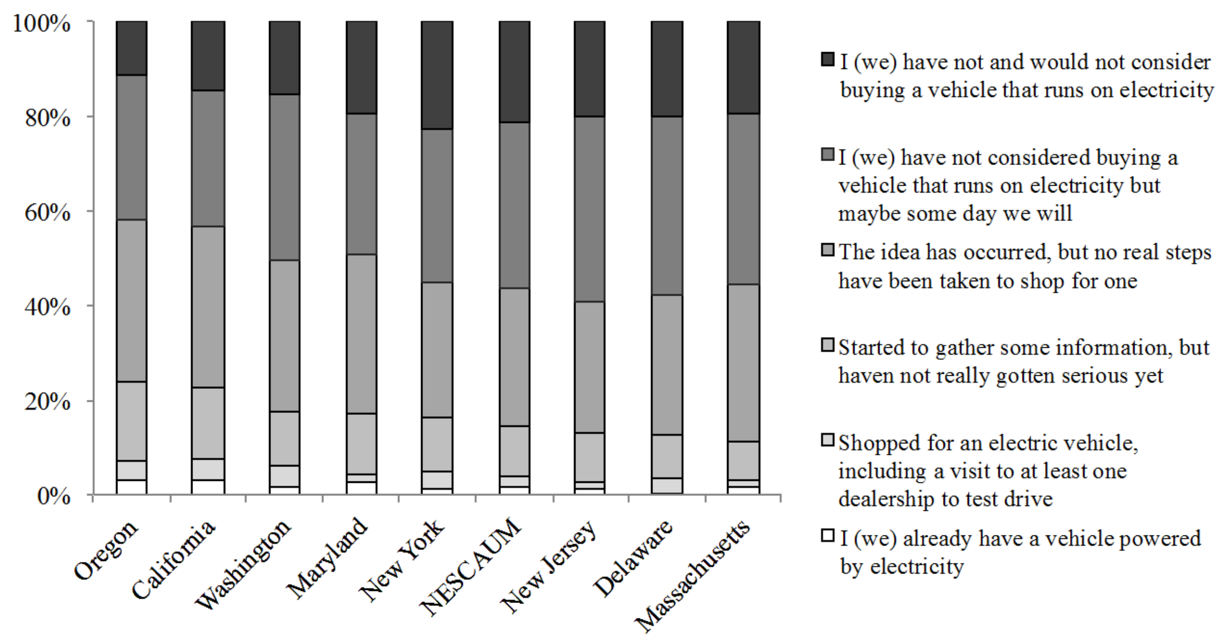
Because their data has only been used in the aggregate NESCAUM regional study, the reader is reminded data were collected from samples of new car buying households in all NESCAUM states, including Connecticut, Rhode Island, Vermont, New Hampshire and Maine. These smaller states do not have individual state analyses because their samples sizes are too small.

PEV and FCEV Consideration

- Levels of prior consideration of PEVs and FCEVs are low among new car buyers across all the study states and the NESCAUM region.
- Still, respondents are more likely to have given higher levels of prior consideration to PEVs and FCEVs in California, Oregon, and Washington than in the NESCAUM region, Maryland and Delaware.
- Prior consideration is higher for PEVs than FCEVs across all states, as one might expect given the tiny number of FCEVs that have been leased and the strictly proscribed regions in which those leases are available at the time of this study (at the time of the survey, limited to small regions within the greater Los Angeles, CA area).

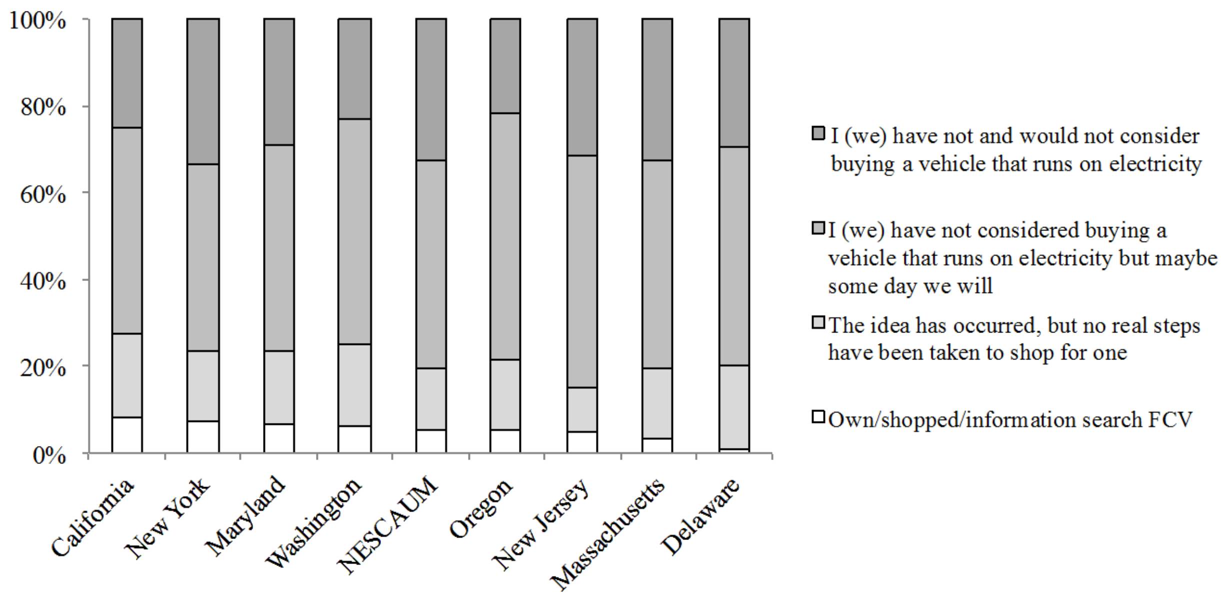
Respondents' consideration of PEVs and FCEVs prior to completing the on-line survey is plotted by state and the NESCAUM region in Figures 32 (PEVs) and 33 (FCEVs). The order of the results from left to right in each figure is by the sum of the three highest or most active levels of consideration: own a PEV (or FCEV), shopped for one including at least one visit to a dealership, and started to gather some information but not yet serious. Though the differences are small, these higher levels of consideration of PEVs are more common among the respondents of all three western states than of any of the eastern states and the NESCAUM region. Further, some degree of actual resistance to the idea of PEVs and FCEVs is more common in the eastern states.

Figure 32: Comparison of Consideration of PEVs by state and region



For FCEVs (Figure 33), the highest levels of consideration have been consolidated into a single category as opportunities to lease an FCEV or even test drive one are strictly proscribed to only a few locations in southern California. Using the same principle of ordering the states from left to right by the decreasing incidence of the highest level of consideration, results in a different order. Notably, Oregon is the state with the highest percentage of respondents at the highest levels of consideration of PEVs but is ranked much lower on consideration of FCEVs. In general, levels of prior consideration of PEVs are higher in every state and region than of FCEVs.

Figure 33: Comparison of Consideration of FCEVs by state and region



Cross-classifying the distributions of PEV and FCEV consideration by state/region confirms the distributions are statistically significantly different. The data are shown in Tables 14 (PEVs) and 15 (FCEVs).[31] The test is whether the state/region (row) distributions of probabilities are the same. The very small probability of getting a larger chi-square value indicates we can be quite confident the row probabilities are different. To illustrate the differences, values for each state have been highlighted in **bold** for each level of consideration where there are more people than expected if the row probabilities were the same. The states and regions have then been ordered top to bottom in the table from those states with more people at the higher levels of consideration to those with lower levels. The general flow of **bold** cells from upper left to lower right in both tables illustrates a flow from higher to lower levels of consideration. The western states are highest in consideration for both PEVs and FCEVs—though the ordering is different.

Another view of this result is shown in Figures 34 (PEVs) and 35 (FCEVs). The dimensions c1 and c2 in the figures divide it into quadrants defined by the row percentages of prior PEV or FCEV consideration (c1) and the column percentages of the states. The reader sees that c1 is defined from top to bottom by high to low prior consideration of PEVs or FCEVs. Further, the markers for California, Oregon, and Washington are all above the origin (the zero point) of c1, that is, the distributions of row percentages for those three states are all shifted toward higher prior consideration of PEVs than are the respondents from Maryland, Delaware, and the NESCAUM region (as shown by their markers on the same side of the origin as the lowest levels of prior consideration). The same results holds for FCEVs.

[31] Massachusetts, New Jersey, and New York are not shown separately in Tables 14 and 15 because to do so would double count their data in the statistical tests.

Table 14: State/Region by Consider PEV

Count Row %	I (we) already have a vehicle powered by electricity	Shopped for an electric vehicle, including a visit to at least one dealership to test drive	Started to gather some information, but haven not really gotten serious yet	The idea has occurred, but no real steps have been taken to shop for one	Have not considered buying a vehicle that runs on electricity but maybe some-day we will	Have not and would not consider buying a vehicle that runs on electricity	Total
California	**51** **3.05**	**78** **4.67**	**249** **14.90**	**568** **33.99**	480 28.73	245 14.66	1671
Oregon	**15** **3.04**	**20** **4.05**	**84** **17.00**	**167** **33.81**	151 30.57	57 11.54	494
Washington	8 1.60	**22** **4.40**	59 11.80	**159** **31.80**	**174** **34.80**	78 15.60	500
Maryland	**10** **2.53**	8 2.02	50 12.63	**134** **33.84**	117 29.55	**77** **19.44**	396
NESCAUM	35 1.46	57 2.38	255 10.66	698 29.17	**833** **34.81**	**515** **21.52**	2393
Delaware	1 0.50	6 3.00	18 9.00	59 29.50	**76** **38.00**	**40** **20.00**	200
Total	120	191	715	1785	1831	1012	5654

Note:

Test	**ChiSquare**	**Prob>ChiSq**
Pearson	126.573	<0.0001

Table 15: State/Region By Consider FCEV

Count Row %	Own/shop/ information search	The idea has occurred, but no real steps have been taken to shop for one	Have not considered buying a vehicle that runs on hydrogen but maybe someday we will	Have not and would not consider buying a vehicle that runs on hydrogen	Total
California	**141** **8.44**	**316** **18.91**	793 47.46	421 25.19	1671
Washington	31 6.20	**94** **18.80**	**259** **51.80**	116 23.20	500
Oregon	27 5.47	81 16.40	**278** **56.28**	108 21.86	494
Maryland	**27** **6.82**	**67** **16.92**	186 46.97	**116** **29.29**	396
Delaware	2 1.00	**38** **19.00**	**101** **50.50**	**59** **29.50**	200
NESCAUM	132 5.52	343 14.33	1144 47.81	**774** **32.34**	2393
Total	360	939	2761	1594	5654

Note:

Test	**ChiSquare**	**Prob>ChiSq**
Pearson	78.524	<0.0001

Figure 34: Correspondence Analysis of State/Region by Consider PEV

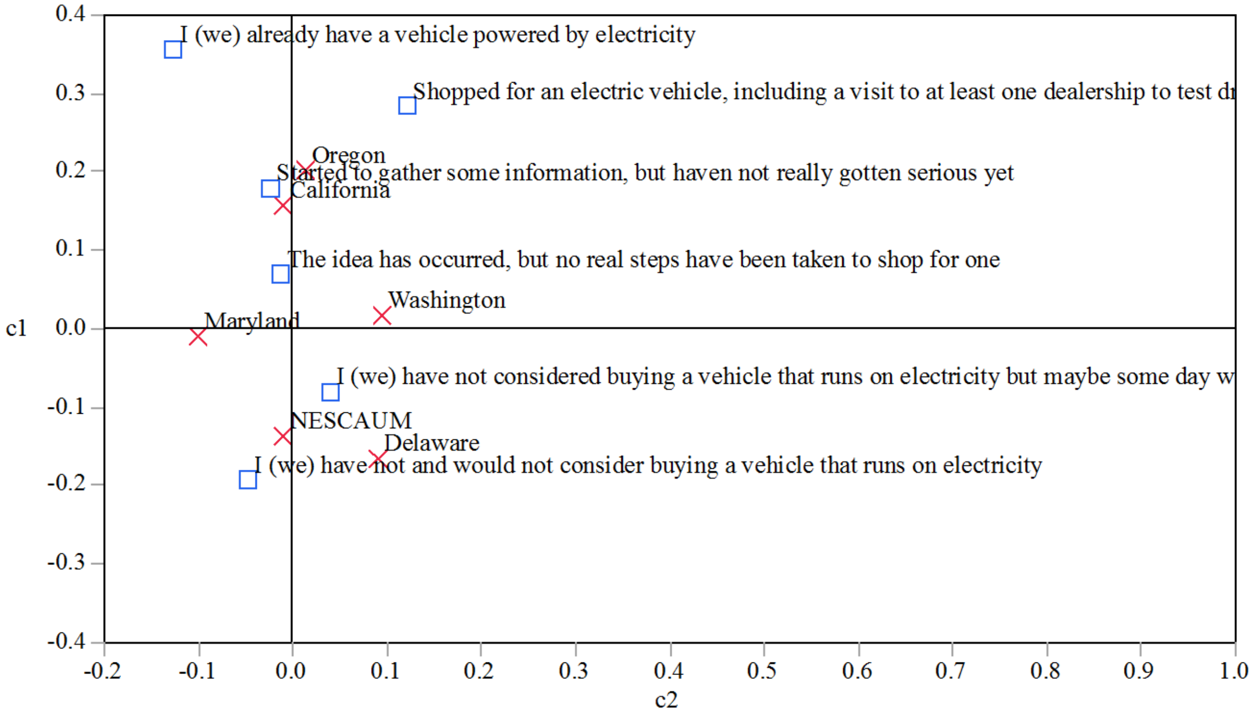
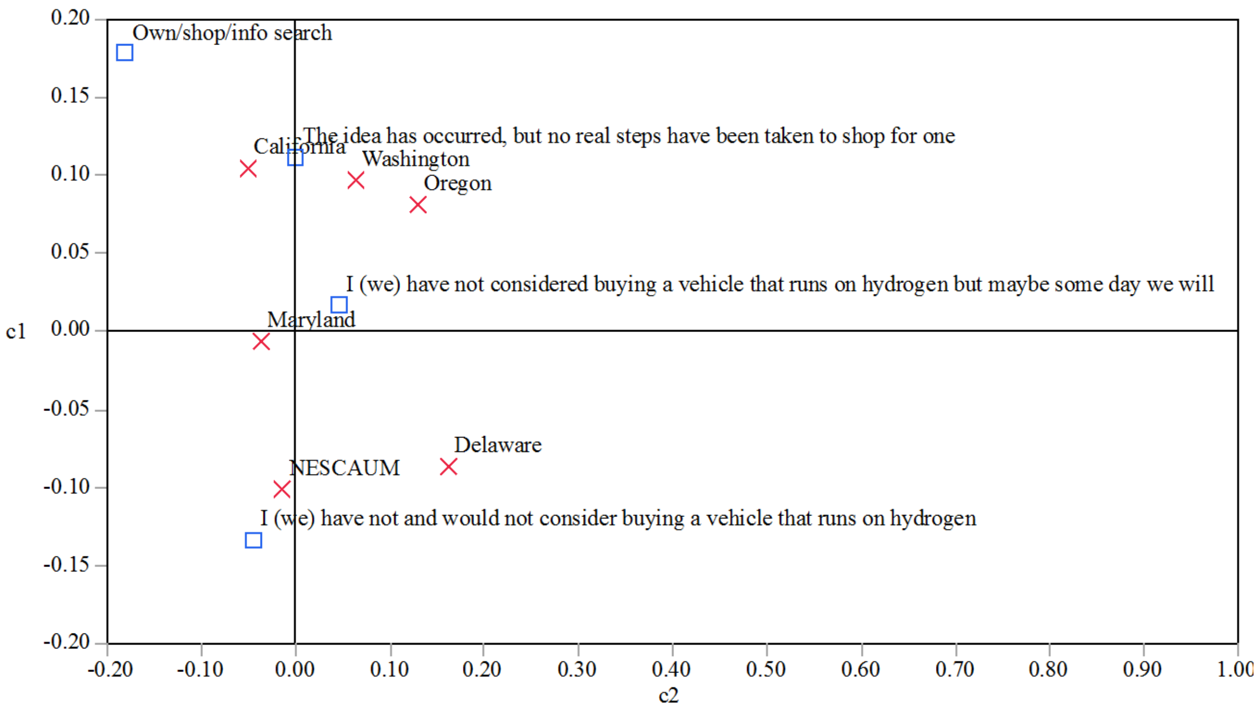


Figure 35: Correspondence Analysis of State/Region by Consider FCEV

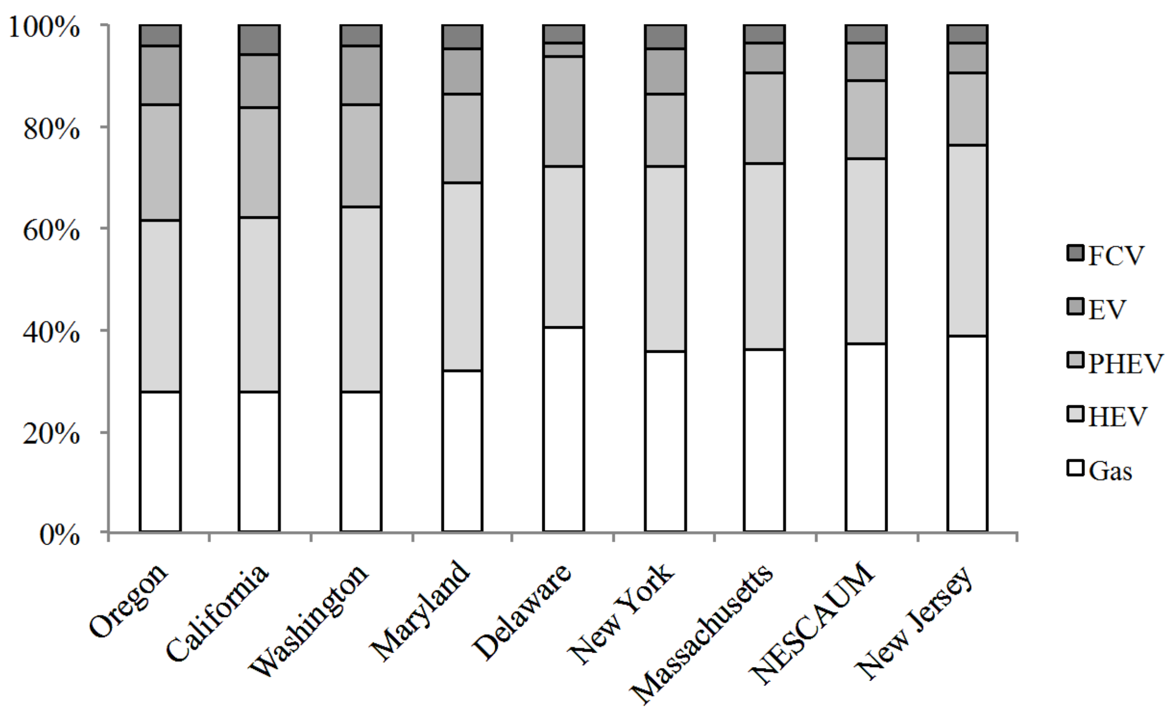


PEV and FCEV Valuation: Drivetrain designs

- In every state and region, fewer respondents design a next new vehicle for their household to be a PHEV, BEV, or FCEV than design them to be ICEVs or HEVs.
- Still, from one-fourth to two-fifths of new car buyers appear ready to consider a PEV or FCEV for their household, i.e., they design such vehicle in the design games.
- The differences between states in drivetrain designs—and in particular between western and eastern states—is stronger than the differences in prior consideration.

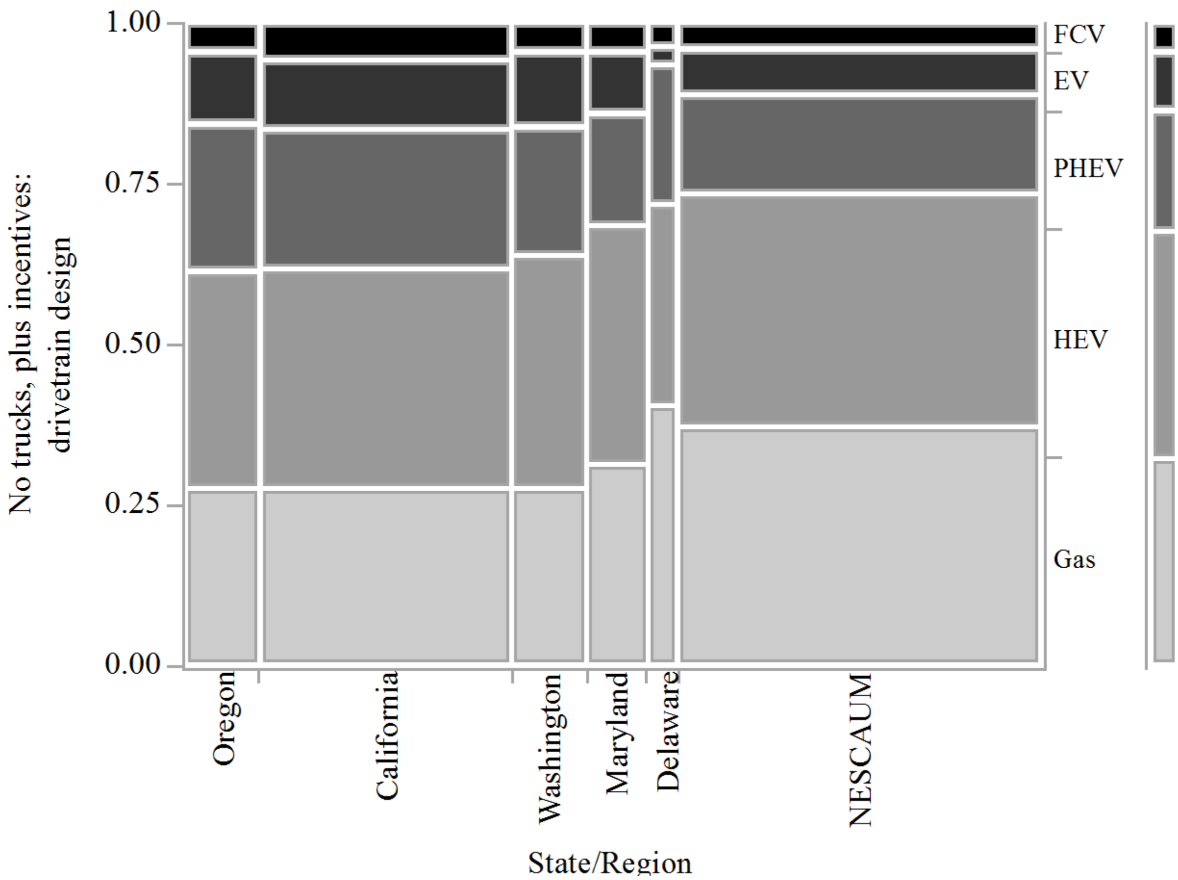
The design games address whether respondents value PEVs or FCEVs highly enough to design one as a plausible next new vehicle for their household based on the conditions stipulated in the design games and their own awareness, knowledge, and experience. The distributions of drivetrain designs (described in the individual state and regional reports) are compared in Figure 36. The results produce the same general order of interest as did the analysis of prior consideration: higher percentages of respondents in the western states created vehicle designs with PHEV, BEV or FCEV drivetrains than do so in any eastern state. The NESCAUM member states had the lowest percentage of PEV and FCEV drivetrains. Still, approximately one-in-four respondents throughout the NESCAUM region did design a PHEV, BEV, or FCEV: nearly four-in-ten did Oregon, California, and Washington.

Figure 36: Drivetrain Types from Game 3, ordered left to right from high to low of the total percent of PHEV, BEV, and FCEV designs



Cross-tabulating the distribution of drivetrain designs by state and region samples allows testing whether the drivetrain probability distributions are statistically significantly different. The cross-tabulation is illustrated in Figure 37 and provided in Table 16. The vehicle design distributions in Figure 37 have been ordered by the total of the percent of respondents who design a PHEV, BEV, or FCEV. The mosaic plot in Figure 37 highlights both the differences between western and eastern states (the vertical axis) and the different sample sizes (the width of each column is proportional to sample size).

Figure 37: Mosaic Plot of Drivetrain Types from Game 3 by state/region, ordered left to right as high to low by total percent of PEV and FCEV designs



The order from top to bottom in Table 16 preserves the rank order of the total percent of PEV and FCEV designs. The chi-square test indicates the row (drivetrain design) distributions are not independent of the state/region from which they were drawn. The cells shown in bold are those in which there are more respondents than would be expected if all the state/region drivetrain distributions were the same. The general pattern of a diagonal of **bold** cells from upper right to lower left illustrates the higher proportion of PEV and FCEV designs in the west and lower in the east (and thus higher gasoline ICEV and HEV designs in the east than the west).

Table 16: State/Region Drivetrain Designs, Game 3

Count Row %	Gas	HEV	PHEV	BEV	FCEV	Total
Oregon	136 27.53	167 33.81	**114** **23.08**	**55** **11.13**	22 4.45	494
California	459 27.52	574 34.41	**358** **21.46**	**184** **11.03**	**93** **5.58**	1668
Washington	138 27.71	**181** **36.35**	**99** **19.88**	**58** **11.65**	22 4.42	498
Maryland	125 31.65	**146** **36.96**	69 17.47	**37** **9.37**	**18** **4.56**	395
Delaware	**81** **40.50**	63 31.50	**43** **21.50**	6 3.00	7 3.50	200
NESCAUM	**890** **37.30**	**861** **36.09**	367 15.38	177 7.42	91 3.81	2386
Total	1829	1992	1050	517	253	5641

Note:

Test	**ChiSquare**	**Prob>ChiSq**
Pearson	106.270	<0.0001

PEV and FCEV Valuation: Who designs their next new vehicle to be a PHEV, BEV, or FCEV?

Logistic regression models of the respondents’ drivetrain designs, i.e., the primary measure of which respondents have a sufficiently positive valuation of PEVs or FCEVs to seriously consider one for their household, were created for each state and the NESCAUM region. The explanatory variables from those models are summarized in these categories:

1. Socio-economic, demographic, and political descriptors of the respondents and their households;
2. Characteristics of household vehicles, travel, and residences;
3. Attitudes regarding the policy goals of PEVs and FCEVs: air quality, climate change, and energy supply and security; and,
4. Measures of awareness, knowledge, and experience as well as prior assessments of PEVs and FCEVs and of electricity and hydrogen as replacements for gasoline and diesel.

The question addressed in this section is not what are the most influential variables, i.e., the variables that have the highest correlation with the distribution of respondents’ vehicle designs. Rather, the question addressed here is which explanatory variables are particular to one or a few states and which are pervasive across states and the different “geographies” of policies and markets they represent.

- Almost no measures of socio-economics, demographics and political affiliations appear in any state or regional model of respondents' drivetrain designs, i.e., given the other variables that do appear in the models, these measures offer no additional explanation for who presently has a high enough valuation of PEVs or FCEVs to seriously consider one for their household.
- The contextual measures appearing across the largest number of state and regional models pertain to whether respondents are likely to be able to charge a PEV at home.
- The measure of vehicle travel that appears in a few models is whether or not the respondent commutes (at least part way) to work in a household vehicle.
    - The model for Oregon is quite different from any other in that several measures pertaining to the households existing vehicles and vehicle travel are included as statistically significant explanatory variables of respondents' PEV and FCEV valuations.
- Of the measures pertaining to policy goals and instruments, those measuring attitudes about air quality are the most common across states and regions.
    - In a few states, whether respondents are aware of federal incentives for alternatives to gasoline and diesel or support the idea of government incentives enter the models of respondents' vehicle designs as statistically significant.
- The conceptual category that provides the largest number of measures across the state and regional models is the category containing measures specific to respondents' prior awareness, knowledge, and assessments of PEVs, FCEVs, electricity, and hydrogen.
    - Whether electricity and/or hydrogen is already believed to be a likely replacement for gasoline and diesel;
    - Personal interest in ZEV technology;
    - Familiarity with all vehicle drivetrain types included in the design games: ICEVs, HEVs, PHEVs, EVs, and FCEVs;
    - Prior assessments of EVs and FCEVs on six dimensions: charging/fueling, purchase price, safety, and reliability;
    - Experience driving vehicles of the different drivetrain types;
    - Whether respondents have already seen PEV charging in the parking facilities they use; and,
    - Extent to which respondents have already considered acquiring a PEV or FCEV.

Socio-economic, demographic, and political measures

Socio-economic and demographic measures test for whether the profile of the early applicants for California's Clean Vehicle Rebates (CVR) defines some sort of boundaries on who might be expected—at least at present—to be interested in PEVs and FCEVs. The socio-economic and demographic profile of those early PEV buyers and lessors in CA is that they are much more likely to be male, upper-middle age, very high-income men with several years of formal education. They are much more likely to own their residence and for that residence to be a single-family home. Political measures are added to help explain whether differences in valuation of PEVs and FCEVs are shaped by political party affiliation or beliefs about the role of government specifically to incentivize vehicles powered by electricity and/or hydrogen.

Appendix C shows that in general socio-economic, demographic, and political measures are not retained as statistically significant explanatory variables in the final models of respondents' drivetrain designs. New York is the only state for which the variable for respondent gender is retained. That New York is a large part of the NESCAUM data may explain why gender also appears in the NESCAUM model. Education is also retained in the NESCAUM model. The effect of respondent gender in New York is contrary to the profile of early applicants for California's CVR—holding all other variables constant at their baseline values, women are more likely than men to design anything but an ICEV. On the other hand, the effect of the education variable in the NESCAUM region is in keeping with that profile of early PEV drivers: more years of education are associated with a higher probability of designing anything but an ICEV. Still, the overall conclusion is that when measures in the other conceptual categories are accounted for (by their inclusion in the model), measures of socio-economics, demographics, and political affiliation do not explain differences in respondents' vehicle drivetrain designs.

Contextual measures: existing vehicles and their use; residences

Respondents' existing vehicles, travel, and residences establish context for their adaptation to vehicles with different operating characteristics such as the limited range per charge combined with home charging of PEVs. In all the state and regional models except Maryland, at least one of these measures is a statistically significant explanatory variable in the state or regional model of drivetrain designs. Though more measures of these contextual factors appear in more state and regional models than do socio-economic, demographic and political measures, it is still the case that comparatively few measures of existing vehicles, travel, and residences have much explanatory power when measures from the other categories are included.

Measures of existing vehicles and their use appear in the models for Oregon, New Jersey, New York, and NESCAUM. Oregon is unique in the emphasis of existing vehicles and their use on the distribution of drivetrain design—five variables pertaining to cost (vehicle price, fuel spending, and fuel economy), use (commuting), and the flexibility within the household for different drivers to use different vehicles. Of these, only the measure for whether the respondent commutes (at least part way) to work in a household vehicle is found in the models for New Jersey and NESCAUM. The model for New York is singular for its inclusion of the measure of how many miles the respondent drives.

A common measure for the ability of the respondent to charge a PEV at home appears in the models for California, Washington, Delaware, and Massachusetts; a different measure appears in the NESCAM model. The measure found in multiple state models has to do with whether electrical service is available at the location they park at home; for NESCAUM the variable simply assesses whether at least one household vehicle is parked in a garage or carport attached to the residence. For Massachusetts, an additional variable distinguishes whether the respondent could install a new electrical outlet near where they park at least one vehicle at home on their own authority or would require permission from some other person or group.

Attitudes related to policy goals: energy security, air quality, and global warming

Relative support for pro-social goals may explain differences in respondent valuation of different drivetrain types. Six of the nine state and regional models include some measure related to air quality. One state model includes measures specific to incentives for alternatives to gasoline and diesel fuel. The NESCAUM model includes both a variable related to whether there is an urgent need for a national transition to alternatives. It also contains a factor related to respondents' assessments of whether electricity or gasoline poses greater environmental and human health risks in their region—again though without specifying what aspects of the environment or human health are at risk. No models contain measures related to climate change.

Respondents' air quality assessments include whether they view air pollution as a "health threat in their region," a "personal worry," and is subject to lifestyle choices by individuals. In California, Maryland, and Massachusetts a factor that combines regional threat and personal worry is associated with differences in drivetrain designs. In New York and Washington, the emphasis is on the personal risk aspect of air pollution. Finally, in Oregon the element of personal lifestyle affecting air quality is the measure associated with drivetrain designs.

In California, Delaware and New Jersey variables measuring awareness of and support for government-provided incentives to consumers are associated with valuation of PEVs and FCEVs.[32] In New Jersey both the variable measuring awareness of federal incentives and another assessing whether governments should offer incentives (or leave the matter to "markets") are associated with drivetrain designs. Note the presence of the variable in the model for New Jersey does not mean that new car buyers in the Garden State are more likely to have heard of the federal tax credit than respondents from other states. It simply means that of all states, only in New Jersey is whether they have heard of the federal incentive associated with the likeliness they incorporate different drivetrains in their vehicle designs. This same variable on the role of government in providing incentives is statistically significant in California. The variable measuring awareness of federal incentives is also in Delaware's model.

Prior PEV and FCEV Evaluation and Experience; ZEV-specific attitude

The final category of variables includes those most specific to PEVs and FCEVs: drivers prior awareness, consideration, and assessment of the vehicles as well as their "fuels," electricity and hydrogen. Whether a respondent believes electricity or hydrogen is a likely replacement for gasoline and diesel fuels is associated with whether she or he designs a PEV or FCEV. Only in California is their belief about both electricity and hydrogen associated with drivetrain design; in the other five states and the NESCAUM region it is only one or the other (and hydrogen may matter in the NESCAUM region because it matters in both Massachusetts and New Jersey).

Whether the respondent has a specific interest in ZEV technology or more generally whether there is someone in their household, "friends and extended family would describe as being very interested in new technology," are statistically significant variables in five state models and the NESCAUM model. The personal interest of the respondent may be significant in the NESCAUM model because it is the New Jersey and New York models.

[32] For purposes of modeling PEV and FCEV valuation, the measure of incentive awareness was limited to the federal tax credit as it is the only incentive available to all respondents in every state. That is, interpreting the answers to the question about whether respondents have heard whether their state is offering incentives depends on whether their state is offering incentives, what those incentives are, how long they have been offered, whether they are offered (or of value) to residents throughout the state, and how vigorously they have been promoted.

Questions about respondents' familiarity with the types of vehicles they would be asked to design later in the questionnaire were framed in terms of whether the respondents believed they are familiar enough "to make a decision whether one would be right" for their household. Questions addressed each of the five main drivetrain types in the study: ICEVs, HEVs, PHEVs, BEVs, and FCEVs. Broadly, differences in familiarity with different drivetrain types are associated with differences in drivetrain designs in four of the state models and the NESCAUM model. California is notable in that familiarity with all five drivetrain types is associated with resulting drivetrain designs. In general, higher self-rated familiarity with HEVs, PHEVs, EVs, and/or FCEVs is associated with a higher likeliness to design one as a plausible next new vehicle for the household.

Respondents may have had preconceptions or prior evaluations of BEVs and FCEVs before they started their questionnaire—or as seems likely given the analysis of the survey and interview data, may have constructed some initial evaluation during the course of completing their questionnaire. They were presented a series of statements about BEVs and another about FCEVs and asked to rate the strength of their agreement or disagreement. The items included their ability to charge a BEV at home, whether they think there are enough places for BEV charging or FCEV fueling, how long it takes to charge a BEV or fuel an FCEV, whether BEVs and FCEVs travel far enough, and how BEVs and FCEVs compare to gasoline powered cars on purchase price, safety, and reliability. Whether tested as individual statements or as a smaller number of factors that combine statements, some variables measuring respondents' prior evaluations of BEVs and FCEVs are associated with their vehicle designs in every state (and the NESCAUM region) except New York and Delaware. Among these measures, those related to BEVs are much more likely to appear as significant explanatory variables than are those for FCEVs: only in California, and only for driving range and fueling time, are prior evaluations of FCEVs associated with respondents' drivetrain designs. The most commonly occurring measure of BEVs is a factor combining respondents' assessments of the relative safety and reliability of BEVs compared to vehicles powered by gasoline. This indicates an additional dimension to the discussion of ZEVs beyond the widely assumed importance of purchase price, driving range, and charging networks.

Driving experience was measured through self-ratings on a scale from "none at all" to "extensive driving experience" with each of ICEVs, HEVs, PHEVs, BEVs, and FCEVs. Some of these measures are associated with respondents' vehicle designs in the models for California, New Jersey, and NESCAUM. In all cases, higher experience with HEVs, PHEVs, EVs, or FCEVs, is associated with higher likeliness of designing such vehicles.

Whether respondents recall seeing charging for PEVs in the parking garages and lots they use is associated with the vehicles they design in the models for six states plus the NESCAUM region. The latter is certainly the case because it is true for the models for Massachusetts, New Jersey, and New York.

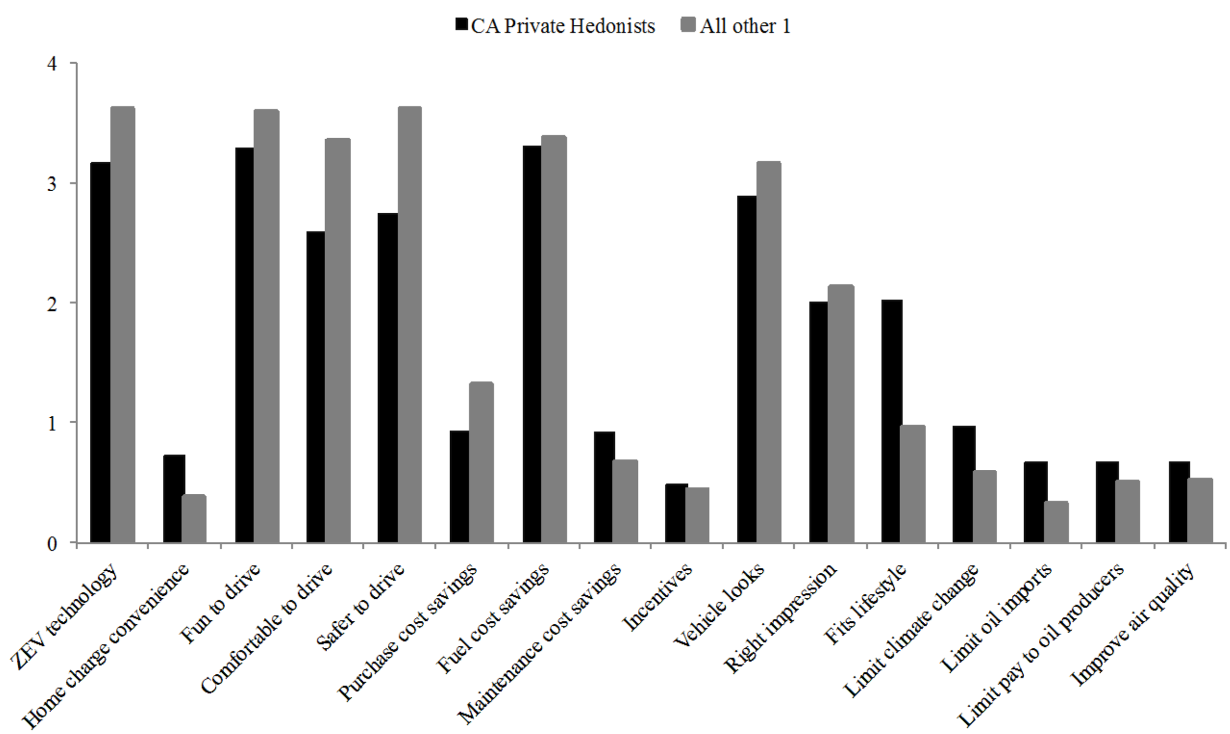
The last set of variables is the extent to which respondents have already considered a PEV or FCEV for their household. The measure of prior consideration of a PEV appears in the models for every state and the NESCAUM region, except Washington. Prior consideration of an FCEV does appear in the model for Washington, as well as those for California, Massachusetts, New York, and NESCAUM.

Post-Game Motivations: Why do respondents design PHEVs, BEVs, and FCEVs?

Analysis of post-game motivations was performed for all participating states. The comparison here is of California to the aggregate of all the other respondents. Figure 38 through 41 illustrates the results of the four-cluster solution from the cluster analysis of California compared to the four-cluster solution for the aggregate of the other states. To simplify the figures, each contains one cluster from California and one from all other states. The question these figures address is whether the same four clusters of motivations exist for designing PEVs and FCEVs. The answer is generally, yes. Though there is no specific statistical test, the figures illustrate that at least for three of the four clusters identified for California, it is possible to match them to clusters of similar motivations for designing PEVs and FCVs in the aggregate of all state samples.

There is little difference in the mean motivations scores between CA and all the other states for the cluster identified in California as "Private Hedonists": people who on average had no highly scored pro-social motivation but appeared to think a vehicle powered by an electric motor will simply be a better car. If anything, this cluster of respondents from all other states exaggerates the effect, with higher mean scores for vehicle specific attributes and lower for pro-social goals.

Figures 38: Comparison of Motivations for PEV and FCEV designs, mean motivation scores for "CA Private Hedonists" and "All other states Cluster 1"



A close mapping is possible for the clusters identified as "CA Pro-social technologists" and "CA Why did they design a PEV or FCEV?" (Figures 39 and 40). Though in the latter case, the matching cluster from all other states has a distinctly higher average score for fuel cost savings.

Figure 39: Comparison of Motivations for PEV and FCEV designs, mean motivation scores for "CA Pro-social technologists" and "All other states Cluster 2"

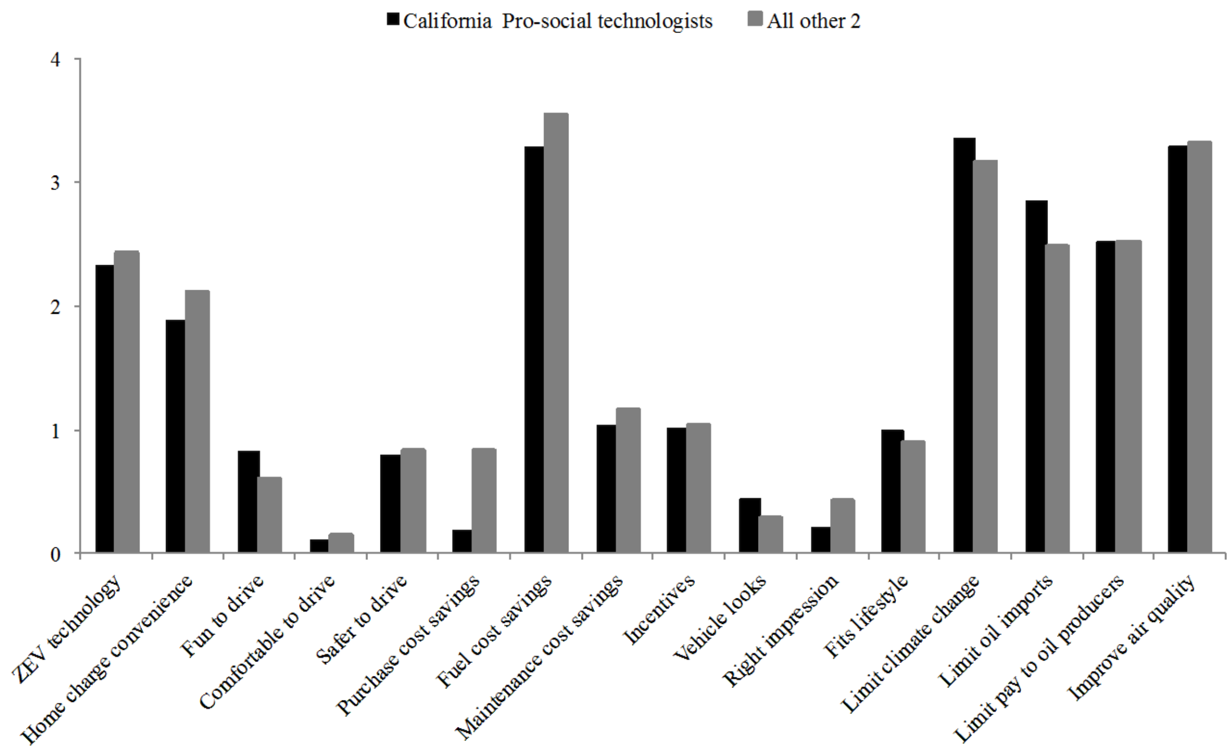
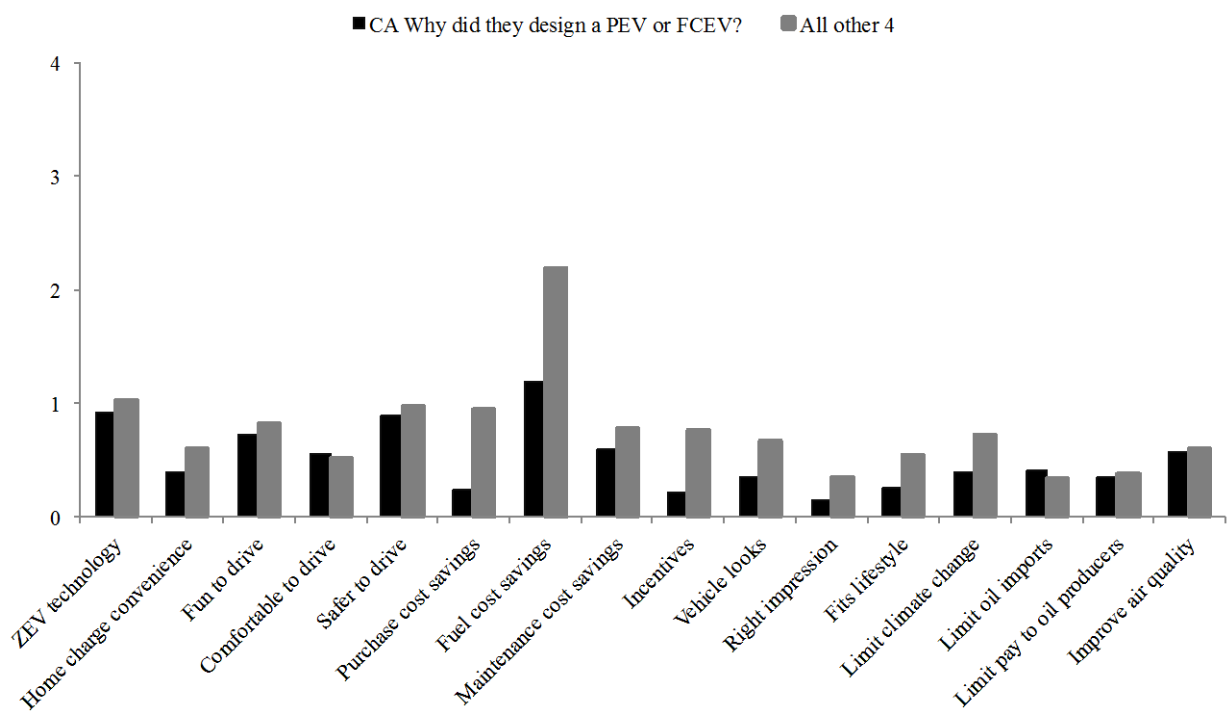
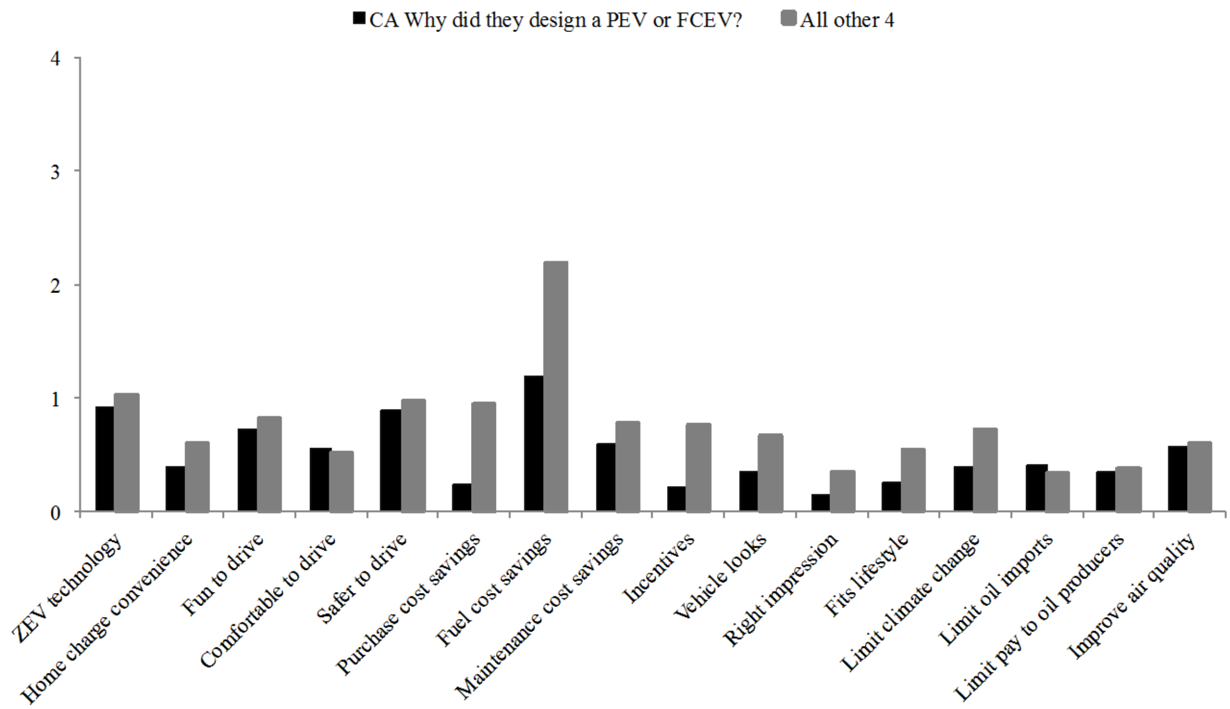


Figure 40: Comparison of Motivations for PEV and FCEV designs, mean motivation scores for "CA Why did they design a PEV or FCEV?" and "All other states Cluster 4"



The one California cluster for which a match from the data for all other states appears not to be appropriate is for the "CA Thrifty environmentalists" (Figure 41). Compared to the "Thrifty environmentalists, "All other states Cluster 3" is more motivated by vehicle attributes (fun, comfort, safety), aesthetics (vehicle looks and making a good impression), and lifestyle. However, on average those in "All other states Cluster 3" score all the cost motivations lower than do the CA thrifty environmentalists. More than any cluster from California and more than the other clusters from the aggregate of all states, "All other state Cluster3" is something of a "generalist" cluster, with above average mean motivation scores in all the categories of motivations: ZEV technology, general vehicle attributes, a variety of costs, aesthetics and lifestyle, and pro-social goals.

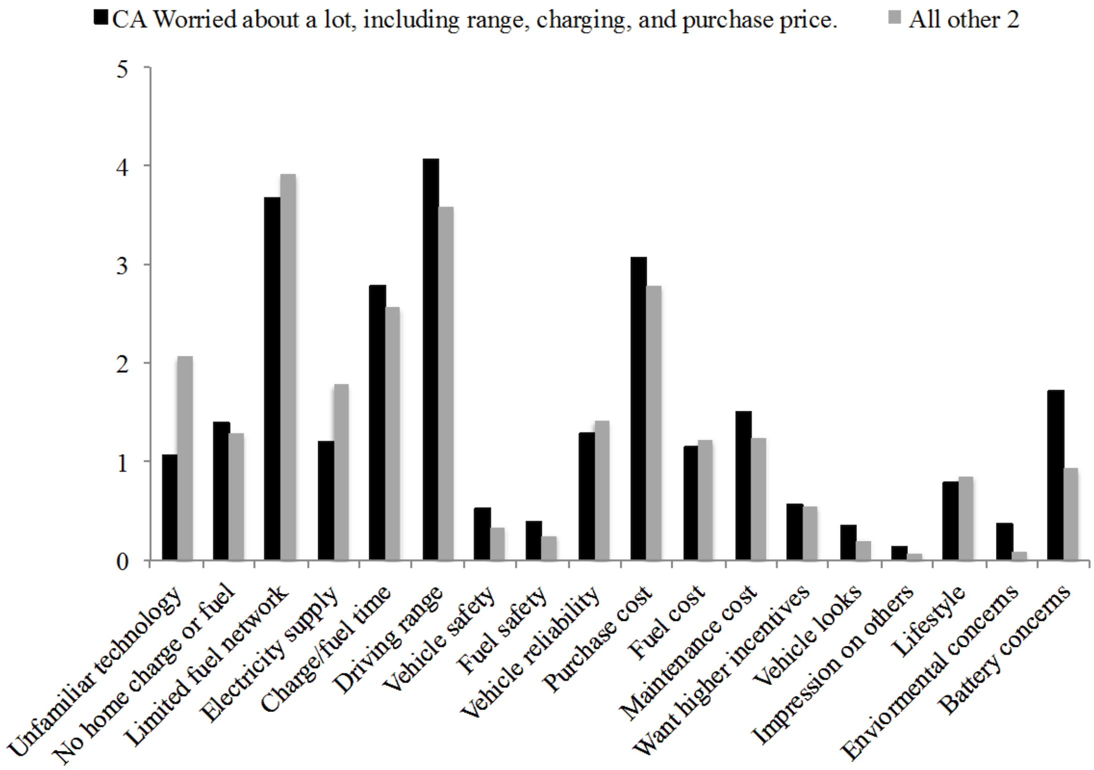
Figure 41: Comparison of Motivations for PEV and FCEV designs, mean motivation scores for "CA Thrifty Environmentalists" and "All other states Cluster 3"



Post-Game Motivations: Why don't respondents design PHEVs, BEVs, and FCEVs?

The motivations of those who design ICEVs and HEVs for not designing a PEV or FCEV are compared here for the California sample and the aggregate of all other states. As in the previous section the result here is that clusters of motivations appear broadly similar between the respondents from California and those from all other participating states. Cluster mean scores are shown in Figures 42 through 44 for three-cluster solutions. A cluster from the analysis of the aggregate of all other states matches well with the "CA Worried about a lot including range, charging, and purchase price" cluster. The all-states cluster gives unfamiliar ZEV technology a higher average score than the CA cluster, but a lower score for battery concerns specifically. Figure 43 shows that though there may be minor differences in detail, there is a cluster in both samples that registers low levels of concern for all the motivations.[33] Figure 44 shows some differences in the mean motivation scores, but not the pattern of which motivations are scored highly. For example, the California cluster has higher mean scores for "no home charging" and "limited fuel network" than does the all other states cluster. However, within the all other states cluster these two motivations are the first and third most highly scored.

Figure 42: Comparison of Motivations against PEV and FCEV designs, mean motivation scores for "CA Worried about a lot including range, charging, and purchase price" and "All other states cluster 2,"



[33] As discussed in the section on post-game motivations for California, these low scores average scores for all motivations are the result of a cluster of people who spend few, i.e., eight to nine, points of the total of 30 points available to them.

Figure 43: Comparison of Motivations against PEV and FCEV designs, mean motivation scores for "CA Expensive, unknown technology" and "All other states cluster 3"

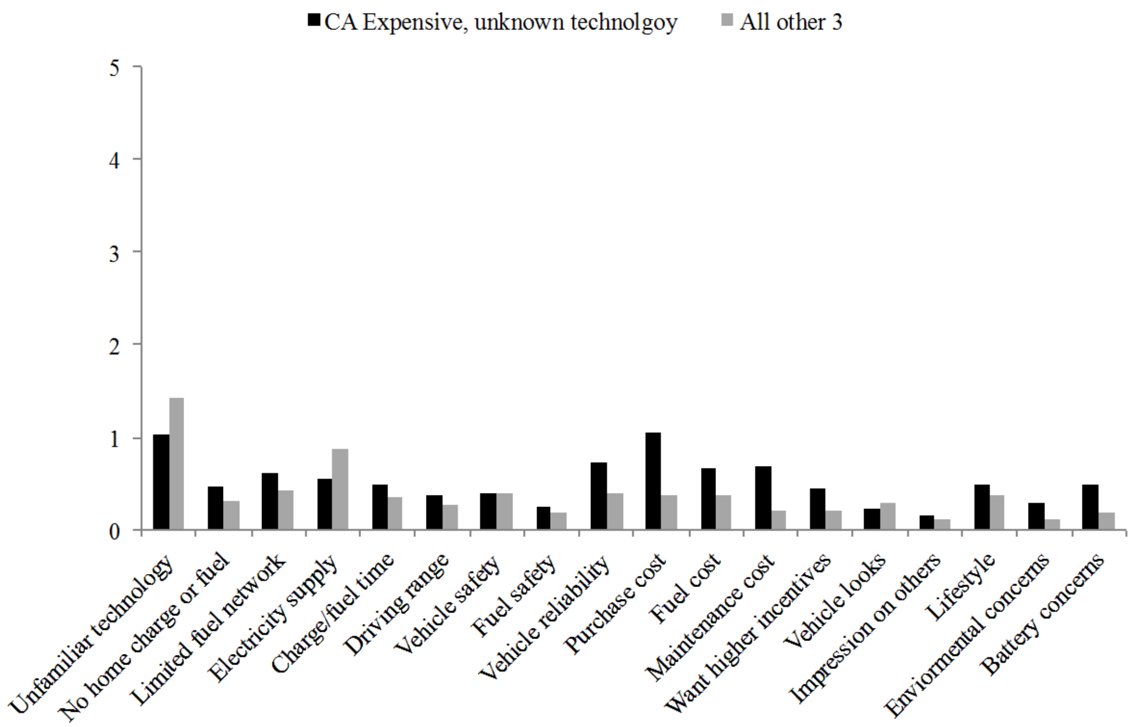
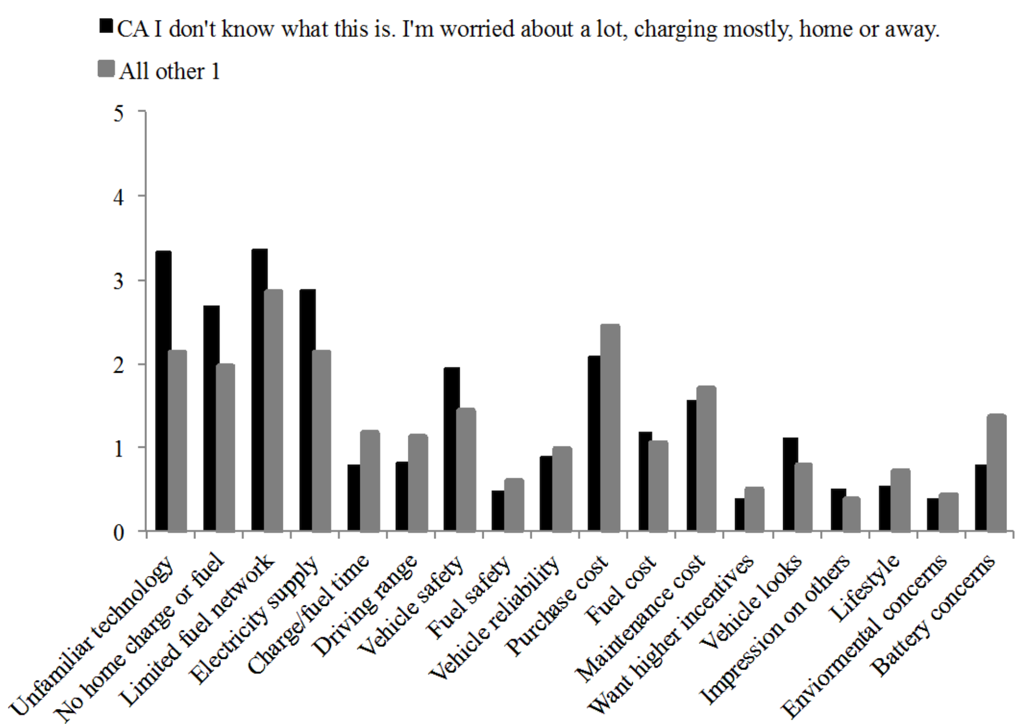


Figure 44: Comparison of Motivations against PEV and FCEV designs, mean motivation scores for "CA I don't know what this is…" and "All other states cluster 1"



RESULTS: POPULATION-LEVEL ESTIMATES OF NEW-CAR BUYING HOUSEHOLDS WITH POSITIVE PHEV, BEV, OR FCEV VALUATIONS

Combining data from several sources allows an estimate of the total number of households that are represented by the survey respondents who designed a PHEV, BEV, or FCEV in the final design game. These calculations are summarized in Table 17. The second through fourth columns estimate the number of households that meet the definition of "households who acquire new vehicles" as defined for this study: households who have acquired a new vehicle since January 2008. The fourth column—Buy new vehicles, %—is an estimate based on data for California only, thus the estimates for all other states and regions depends on the assumption this percentage in other states is similar. Taking the product across each row produces the Population Estimate in the sixth column. The result is that something like three million households—who already spend the income, wealth, or credit it takes to buy new cars—sufficiently value the idea of a vehicle that runs on electricity (in part or in whole) or hydrogen to design one as their household's next new vehicle.

Table 17: Population estimates of new-car buying households with positive PHEV, BEV, or FCEV Valuations

	Households[1]	Vehicle available[1]	Buy new vehicles, %[2]	Design PEV or FCEV in Game 3	Population Estimate, 1,000s
Oregon	1,522,988	92%	33%	38.7%	181
California	12,617,280	92%	33%	38.1%	1,476
Washington		93%	33%	35.9%	295
Maryland	2,155,983	91%	33%	31.4%	204
Delaware	339,046	94%	33%	28.0%	30
New York	7,255,528	70%	33%	27.9%	474
Massachusetts	2,538,485	87%	33%	27.7%	205
New Jersey	3,188,498	88%	33%	23.7%	222
NESCAUM	16,078,204	81%	33%	26.6%	1,151
Total[3]					3,337

1. US Census http://www.census.gov/quickfacts/table/HSG010214/00 and American Community Survey. Figures are as of July 1, 2014.
2. Based on a survey in November 2014 by UCD of all car-owning households in California the subset estimated to meet the definition of new car buyers used in this study.
3. Total does not double count Massachusetts, New York, and New Jersey as part of NESCAUM.

RESULTS: ELABORATING ON THE PROS AND CONS OF ZEVS: INTERVIEWS OF SURVEY RESPONDENTS

Results from the follow-up interviews with survey respondents in California are discussed here. Sampling for the interviews was not intended to produce representative sample in any single state or across all three states in which interviews were conducted. Rather, the interviews elaborate on respondent awareness, knowledge, consideration, and valuation of ZEVs. As described earlier, interviewees were recruited based on their vehicle designs from the on-line survey. Households that did and households that did not design a PHEV, BEV, or FCEV were interviewed.

The interviews are summarized in five thematic sections:

1. Respondents who can imagine owning a ZEV (or ZEV-enabling vehicle);
2. Those who cannot imagine owning a ZEV;
3. The lure and lore of Tesla;
4. Frequently asked questions; and,
5. The future of cars.

These five themes are products of the analysis of the interview notes and recordings; they are not necessarily subject headings in the interview guide. As one of the sampling goals for the interviews was a balance of survey respondents who did and did not design a PHEV, BEV, or FCEV in their vehicle design games, there are about as many respondents discussed in the section on respondents who can imagine life with a PEV or FCEV as those who can’t. Statements made here about the prevalence of any result apply only within each of these two sections. The other three sections include statements from any participant regardless of their drivetrain design.[34]

1. Respondents who Can Imagine Owning a PEV or FCEV

Some participants can imagine owning a PEV or FCEV and using it as their daily vehicle. They discussed what they know about such vehicles, including available vehicles, technology, charging and fueling options, and incentives. Motivations for purchase, such as saving money and being environmentally friendly, were discussed, as were barriers to purchase. This section concludes with a discussion of how these respondents ultimately chose a PEV or FCEV in the design games. Understand that some people who imagined they could use a PEV or FCEV on a daily basis during the course of their interview had not designed one in their survey.

What do they know about PEV or FCEVs?

Vehicle Types and Technology

These interview participants’ prior knowledge of different types of PEVs or FCEVs varied considerably. There was a lot of confusion about the difference between HEVs and PHEVs; they

[34] All survey respondents were provided an opportunity to leave comments at the end of their on-line questionnaire. These comments are cataloged at the end of Appendix E.

tended to call both "hybrids" without demonstrating an understanding these are two different vehicle types. Most could name at least one BEV, usually the Nissan Leaf or Tesla; many said they were familiar with the idea of ZEVs but didn't know specifics. A few were well versed in the differences between the technologies and could name a variety of manufacturers who offered PEVs. One owned a PHEV; several had considered purchasing (in their actual lives) a PEV but chose an ICEV instead. Only one of these was familiar with FCEVs.

Recharging/Refueling

Participants' knowledge of recharging PHEVs and BEVs varied widely; some knew nothing about how long charging takes, how much it costs, or where it is available. Others had guesses as to the length of time it takes to charge and thought the cost of charging was less than the cost of gasoline. A few thought chargers were ubiquitous.

Those who were not aware of public chargers were concerned about how they would find a charger when needed. Participant 4731 said,

> "I'm thinking what if I do drive to LA? That's 100 miles away, and I have to drive home. What if I don't see a charging station? I'm always the 'what if?' person. Plan for the worst; hope for the best."

Some had seen PEV chargers around town but weren't sure if there were enough to make the cars reliable, especially on longer trips where they didn't know where chargers were, if any. Participant 2710 said,

> "You know where the gas stations are. I mean when you're away from home you don't, but you know how to find them. But I haven't seen any signs on the freeway that say, 'Charging station over here.'"

Other participants thought there should be chargers available wherever they traveled, in town and on longer trips, and imagined this would increase their confidence enough to contemplate purchasing a PEV. Participant 780 explained,

> "I know I see more of them nowadays as you drive around. We see some parking lots now that have charging stations…I'm sure those are going to increase in the future. That could influence the decision [to buy a BEV]."

While the deployment of PEV charging has been widely argued to be an important sign of the viability of PEVs—and BEVs in particular—participants held differing views. The distinction between away-from-home charging as necessity vs. perquisite is captured by differing views on workplace charging. One participant discussed the charging of BEVs at his wife's workplace. While workplace charging is touted as important supportive infrastructure, he had a different interpretation: BEVs were not workable because they were constantly charging—which to him meant they could not travel far without needing to be plugged in for an extended period of time. In contrast, other participants discussed the appeal of being able to charge at work. And yet another group were indifferent to workplace charging (though still able to imagine they could own a BEV), either because they were already retired or anticipating changing jobs.

A few had read stories about charging etiquette, or a lack thereof. This seemed more likely than not to put them off the idea of public charging; they did not want to have to compete for charging.

Driving range was generally discussed in terms of how often they would need to charge and several agreed that range was not an issue if they had an ICEV for longer trips. Participant 4222 explained thinking of a BEV as a second car,

> ”[Range] that’s just not an issue...if [long trips are] not what it’s going to be used for, you don’t have to worry about that.”

Some participants knew they would be able to charge at home. A few—though attracted to the idea of PEVs—were uncertain if they would be able to charge at home because they lived in condominiums with homeowners’ associations that may prohibit EVSE installation.

Particular to FCEVs, participants were mostly concerned about a lack of fueling stations; they didn’t know where to fuel a FCEV. One participant said he would require a home fueling station because he wanted a reliable source of hydrogen should he purchase an FCEV. The unknown cost of hydrogen was also an issue.

Incentives

Most people who could image owning a PEV or FCEV had some idea incentives were available. The few that didn’t either assumed there were incentives but didn’t know specifics, or thought it would be too cumbersome to apply for them so did not seek out information about them. Within the context of the design game, many were interested in whatever incentives they thought saved the most money.[35] Participant 5871 explained,

> “If the incentives were there it would make me much more likely to buy it…I would think that it would swing the pendulum the other way to make it at least 70-30 in favor of the plug in hybrid.”

Others knew the specifics of the California and federal incentives while others did not know specific numbers but thought the incentives would bring the price of PEVs to the same price as ICEVs. Several were more interested in the percentage of the vehicle purchase price they would receive, with desired percentages ranging from 10 to 30%.

A few were most interested in a home charger purchase incentive, or said they would put any money they got as a rebate (on the vehicle) toward the purchase of home charger. Participant 3093 explained,

> “For the electric, that at least makes that a little more appealing. Just knowing that you’re definitely going to have a place at home to charge it.”

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[35] Recall that in the final design game all PHEVs, BEVs, and FCEVs are eligible for the equivalent of the federal tax credit. Respondents then choose one additional incentive: a state vehicle incentive, a state home charger incentive (of equal dollar value to the state vehicle incentive), HOV access for single occupant vehicles (for a specified time period), reduced tolls (for the same specified period as HOV access), or they could assume access to workplace charging.

Many found HOV access for single-occupant vehicles to be the biggest incentive because it saved them time. Participant 1565 said, “That HOV sticker means a lot to me.” She continued to explain that it has symbolic meaning to her as well, “My goal is to get the white sticker. It’s like a status symbol.” Others found little to no value in the HOV lane sticker either because they were retired and did not commute or they commuted at a time when traffic was minimal. Participant 4222 was against HOV lane stickers as an incentive, saying,

> “I’m not the biggest fan of the stickers. They definitely work as an incentive, clearly, but…I think there are enough incentives for clean vehicles already.”

A few found workplace charging to be a big incentive. However, it seemed to be less a necessity to complete their travel than a source of free electricity—they imagined they would be able to fuel their PEV for free. Notably, the option of workplace charging was not described as “free electricity” in the survey but was assumed to be free by these respondents.

Some thought incentives were nice but not sufficiently motivating. A few said that none of the offered incentives would move them to purchase a BEV or FCEV. Participant 3142 talked through his thought process regarding most of the incentives,

> “So [incentives] would pay for a charging station anyway. The HOV lanes, I’m fine with not using those around here…so that’s not something that’s really necessary. I don’t hit traffic on the way to work or on the way home so that wouldn’t be much of an incentive for me. Or the tolls. And I wouldn’t be plugging in at work. So those ones just wouldn’t be as attractive to me.”

Motivations for acquiring a PEV or FCEV

The Appeal of PEVs: cost and convenience of electricity vs. gasoline, environment, new technology

The motivations for buying PEVs included cost savings, convenience of home charging, environmental benefits, and new technology. Many of these respondents compared their imagined costs of owning and operating a ZEV against an ICEV and imagined a PEV would save them money on fuel. Participant 217 explained,

> “So I’m spending probably about 100 dollars a week on gas…so if I had a Leaf that would actually save me money, considerable money.”

A few talked about gas prices continuing to rise and the need to find alternative fuels to avoid this, as Participant 3093 explained,

> “I do think it’s important to find alternatives …because the price of gas. I think it’s going to continue to go up so if you could find alternatives so that you’re not spending all that money on gasoline.”

Some discussed the ease of charging at home and how it would liberate them from going to the gas station. Participant 2710 said,

> “I don’t like going to the gas stations…so if I could just charge my car up at home that would be nice.”

Participant 2189 discussed the cost savings, convenience of not going to a gas station, and the amount of time it would save them,

> "Fuel is a big expense for us and not only is it an expense it's a hassle. Because you have to go to the gas station and you have to fill up and you know it's always an inconvenient time that you have to do it. If you can cut down on that wasted time it's a big plus."

Some participants spoke of environmental benefits in only the most general terms. Participant 126 spoke about the environmental benefits of driving on electricity, saying,

> "You kind of feel like you're still contributing to the ecology. You're kind of helping somewhat."

However, most of the participants discussed environmental benefits in terms of lowering emissions. Participant 984 said,

> "If you could get rid of those emissions and have a cleaner environment for us to breathe, that would be a plus."

And a few added other social or policy goals to environmental goals. Participant 362 said,

> "I think it's a visible presentation of people trying to do something new to help out the environment and help out our country. Helps get off petroleum and all that good stuff."

Several participants imagined using their home solar power to fuel a PEV. Participant 889 explained,

> "We would be drawing from that which would be the ideal situation. You talk about 100% renewable zero pollutant generated. If we did ever go to an all electric car we would obviously plug into our house where 98% of our electricity comes from solar panels."

Other societal benefits or policy goals were mentioned by a few. Some liked the idea of using a fuel that came from a steady power source and others were interested in reducing the US dependency on foreign oil.

Others discussed positive attributes of the vehicles themselves as being their motivators, in particular the "cool" components of the technology. Participant 2862 explained,

> "There's the cool components for just having something that's new. You know, feel like you're doing something good and being on like the cutting edge of something…the chance to push forward this new technology is appealing to me."

Another, Participant 5627, talked about how fun they are to drive, saying,

> "You can play 'beat the mileage' among other things. Or try to maximize your mileage."

A few liked how quiet vehicles with electric motors are and the lack of maintenance required.

Participant 3823 thought ZEVs are the direction the auto industry is headed, saying,

> "That's where I think the industry is going. I think anyone who is buying a conventional or gas car these days is not very farsighted. From an economic, from an environmental, from a lot of perspectives."

While Participant 2189 spoke about PEVs already becoming part of the mainstream, saying,

> "It's already becoming normal…I think we've passed that hump so to speak."

The Appeal of PHEVs: Opening the door for BEVs?

Particular to PHEVs, some participants spoke about being motivated by the security of having a gasoline back up in the car, as Participant 2169 said,

> "I just think I need to have that security feeling, like if something goes wrong electrically I still have the gas back up."

Others thought a PHEV was a good gateway car to a BEV, as Participant 2710 explained,

> "Because then you would get used to knowing you've got to charge the car, but yet you've got your gas back up. So it would get you started on an electric car without going all electric."

Participant 2189 owned a PHEV and discussed why they like the car,

> "We selected the plug-in hybrid and that has been incredible as far as the savings that we have on gas. We have a charger at home and it's just really quick and easy. I mean you get a charger I mean literally within an hour, you have a car charge. It's fast."

The Appeal of FCEVs: Its only emission is water

Only a few participants discussed motivations toward FCEVs; they primarily liked the idea of water as the only emission. Participant 2864 said,

> "Like usually hydrogen and the ways it's done is that the resulting emission is water or steam. And as far as I'm concerned, there's nothing polluting about water at the end of the day."

Two participants compared BEV emissions with FCEV emissions, as Participant 4130 explained,

> "It [FCEVs] absolutely gives off no emissions to the environment that are harmful. You know electricity has to come from somewhere. You're using some sort of a fuel to get the electricity unless it's hydro electric."

Barriers and motivations against PEV or FCEVs

The discussion of barriers and motivations against PEVs and FCEVs are of two general types. First, some barriers are the flipside of motivations for ZEVs. This can take the form of two people interpreting the same thing oppositely—one sees workplace charging as a positive sign PEVs are becoming practical while another sees it as a sign they are not—or something that is important to one person not being important to another. Second, the discussion of barriers and motivations against PEVs or FCEVs often reveals respondents' misunderstandings or lack of understanding.

Barriers to BEVs

Despite their ability to imagine—on balance—owning a BEV, participants still discussed barriers to their adoption. Primary barriers included concerns about range and charging, environmental effects, and affordability. As with the positive motivations for BEVs, the concerns of range and charging are often intertwined. These discussions of barriers often reveal ambivalence on the part of the participant, a back and forth between the motivations for and against. This is seen in the first illustration of concerns with range.

Concerns about Range

Many imagined they would not be able to complete their daily driving needs, let alone longer trips. Participant 1565 said,

> "I would love to not use any gas but the range isn't there. It's just not there for what I need to do."

This requirement for range is pushed even further—to the idea that the BEV must have the same range as an ICEV by Participant 984,

> "It's got to have the range. It's got to be able to go more than just 5 miles down the road and pick up some bananas and come home. It's got to be able to do what my combustion engine will do. Otherwise it's worthless because it's not going to give me the same performance I have now."

Others express their concerns with range in terms of long trips. Participant 2710 explained,

> "What if I'm on my way to Tahoe and there's no place to charge up, you know? What do you do? That scares me. I mean running around town I'd be fine but it scares me thinking I can't go very far. Like I'm tethered here."

Concerns about Charging

Charging came with its' own concerns for many participants. Some lacked the authority to install a charger where they lived, others were concerned about forgetting to charge, the unknown cost to charge, the amount of time it takes to charge, or finding a place to charge away from home.

Range and charging often seemed to form a single problem. Participant 5627 said,

> "The short range vehicle was useless because you're too busy charging it."

Similarly, another participant spoke about the needs of his wife's coworkers who drive BEVs to charge them at work daily. He interpreted this as a sign of the limits of BEVs, explaining,

> "If people that my wife works with are driving to work, driving 20, 25 miles to work and they have to plug in during the day so they can get home…when is the battery technology going to be to the point where you drive to work during the

> day, leave it sitting in the parking lot and drive it home without having to worry about charging?" (798).

Some were concerned with charging on longer trips and weren't certain there were charging stations outside of major cities or outside of California. Participant 3093 was concerned about having a place to charge a BEV, saying,

> "My biggest thing would be knowing I have a place to recharge…that's why when I think about maybe taking a long trip I'm just thinking, 'Ok where would we get this?'"

One participant thought charging on longer trips an inconvenience, saying

> "It's not convenient by any means…why would you want to stop…it's obviously inconveniencing my family. So I don't think it's worth it…at this point," (6456).

Others spoke about the need to plan charging as a barrier, itself:

> "I think that's part of the problem with electric cars…you can't just put some gas in there and go…you have to plan your trips better. Make sure you're fully charged before you leave. These are all things I would be concerned about," (2112).

Participant 780 had similar concerns,

> "Now you're going to have to start thinking how far is it that you're going to go to a place you're not really familiar with…I get an electric vehicle I'm going to have to start doing some more thinking, calculating. And then it starts imposing potential limitation."

Some thought that they would have to have an ICEV as a back up car for instances when they forgot to charge or went on long trips, which they saw as a barrier. Participant 4634 explained,

> "Then you're forced to buy another car anyway because if you have to go for a longer trip…and if you forget to charge your car you don't get to drive it. It's risky that way."

Environmental Costs

Although these participants tended to believe BEVs were better for the environment than ICEVs, they were still concerned about whether this is true. They brought up battery production and disposal as well as electricity production. These questions can be made more pressing if the respondent thinks conventional cars are getting cleaner. Participant 362 summarized concerns regarding BEV batteries,

> "A lot of cars do advertise…that less pollution is coming out of the tail pipe. But what sort of toxic materials go in to making these batteries? How often do those

> need to get replaced and what's going to happen to those? Do we just throw them away?"[36]

Affordability

Several participants wanted to purchase a BEV but could not afford the price of the vehicles they saw in the design games or knew (or imagined) BEVs actually cost. Some were also concerned about the price of electricity. Participant 984 explained her concerns in terms of not knowing the price of charging a BEV,

> "There's no meter on there. There's nothing telling you ok you just spent 15 dollars…today I can only afford 10 bucks in gas to get back and forth to work until pay day and if I plug it in and fill it up I just spent 80 dollars…I can't afford to pay that."

Other Barriers to BEVs: Too few and too new

Some specific barriers to acquiring a BEV had to do with the limited design options or capabilities other than range and charging time. These respondents didn't think BEVs were fun to drive and were slow, too quiet, and too small, can't tow, don't come in an SUV, and are ugly. Participant 798 summed up his feelings by saying,

> "I want a normal looking car…it has to be visually attractive. I'm not going to buy something that may be environmentally better but it looks like crap."

Others were concerned because they lacked information on the technology. Participant 2864 said,

> "I'd rather let someone else ride out the bugs because first year cars always have something wrong with them."

Participant 3823 similarly said,

> "I don't believe in being a guinea pig."

Barriers to PHEVs

While some of these respondents had seen PHEVs as opening the door to BEVs (by offering an always-available gasoline backup), others were concerned about the complexities of joining two systems. One cited specific engineering issues and another spoke specifically about not wanting a vehicle that mixed technology types in case there was an issue.

Confusion about how PHEVs work—specifically a lack of understanding about how that "always-available" backup works was evidenced by some discussions of the problems respondents' perceive with PHEVs. One didn't want to have to charge while traveling alone on long trips to visit family—revealing they did not understand they would not *have* to charge. Another participant elaborated on this point: they thought people in general don't know the

[36] No interviewee mentioned the end of life disposition of conventional ICEVs.

difference between HEVs and PHEVs or how far they drive each day, so when they hear the electric range of a PHEV, they think it's too short.

Barriers to FCEVs

This group discussed three major barriers to FCEVs: 1) fuel availability, cost, and the related matter of driving range, 2) safety, and 3) environment. Most people in this group did not think there are enough, if any, fueling opportunities for hydrogen. They don't know where they would fuel, how much it would cost, and how far they could travel. One participant compared running out of fuel with a BEV versus an FCEV and said,

> "If you run out of electricity you can always get somebody to tow you to a place where you can get electricity. Well that may not be possible with a fuel cell car," (2189).

Some were uncertain of the safety implications of hydrogen. Participant 126 said,

> "It sounds kind of scary. When I think of hydrogen I think very explosive. So if you get hit by another vehicle are you just going to go whoosh?"

A few were skeptical of the environmental impact of hydrogen, as Participant 5627 explained,

> "Even though they say, 'Well, the hydrogen fuel cells just put out water,' the water is going to be impure because it's going to pick up chemicals from the electrolytes. So you probably have to collect and dump that in some kind of toxic waste."

ZEV-enabling and ZEV Designs

While each of the participants in this category could imagine driving a PEV or FCEV, as a group they designed a variety of PEVs during the design game; none of these interview subjects designed an FCEV.

Those Who Designed a BEV

Two interviewees designed a BEV during the vehicle design games. Participant 4731 chose a BEV version of her current car, explaining,

> "Since I already have a Honda Fit I know what they're all about. And this is just like buying it again but getting a better one. And by better I just mean it's electric, it's better for the environment, you're not buying as much gas, it's going to save me money and be better for everything."

At the prices used in the games plus the incentives offered in the final game, she wanted the longest range offered in the game, 300 miles. Participant 2253 designed a BEV with much shorter range, 100 miles. Still, with their driving they expected to only charge once every seven to ten days; they don't want to charge everyday due to concerns over battery life. They explained how they imagined they would use a BEV,

> "That's one reason why I want to go with an EV, electric car for the next one. Everything would be locally. We don't drive 300 miles in a day. We'll have the other car if we go any distance and every day usage will be with an electric car."

Those Who Designed a PHEV

Some variant of a PHEV was the most common design among this group, who could imagine life with a ZEV-enabling vehicle or ZEV. Many who designed a PHEV wanted to drive on electricity, but liked the flexibility to travel farther in a PHEV than in a BEV because of the "gasoline backup"—while using only electricity in town. Most wanted the highest electric range offered or that they could afford and thought a PHEV was practical in that it would cover most of their needs.

Many thought a PHEV was a stepping-stone to eventually driving a BEV. Participant 2169 owned an HEV but was not comfortable going to all-electric yet; they imagined a PHEV would allow them to gain confidence in electric-drive technology without committing 100% to all electric drive. One participant discussed their decision making process,

> "The first consideration was always first and foremost price…the second consideration was the different options, electric, hybrid, fuel, etcetera. What were the ranges before needing to refuel or recharge. And from there how long to refuel and recharge," (889).

One participant wasn't sure if they preferred a PHEV or a BEV,

> "I like the idea of being fully electric and totally divesting off of gasoline usage, and I like the idea of having a vehicle that still has a pretty solid driving radius and could be filled up anywhere. Definite benefit there. Like I don't know if there's a strong preference between these two options once they're idealized," (4222).

Those Who Designed an HEV

A few participants designed an HEV, despite the interest in PEVs or FCEVs expressed in their interviews. One participant designed an HEV because after playing around with the PHEV and BEV designs, they decided they didn't have enough information to judge what would suit them best; an HEV was the option with which they were the most comfortable. Another participant chose an HEV because they didn't understand the difference between an HEV and PHEV. After learning the difference in the interview, they were then more interested in a PHEV because they would be able to drive on electricity most of the time and still have gasoline as a backup. One participant was interested in an HEV because it got them the best mileage for the price. They would have liked a BEV or FCEV but the price of those vehicles was too high.

Those Who Designed an ICEV

Three of these participants designed an ICEV in their design game. Participant 2628 chose to stay with an ICEV because the cost of a PEV or FCEV was more than they could afford. If the price of a ZEV were affordable to them then they would like a home charger and a charging station on the way to Las Vegas. For trips longer than that they would rent a car. Participant 2189 chose a full-size ICEV truck in the design game because a full-size truck is their desired body style for the next vehicle their household will purchase. After that, they are interested in a PHEV with 80 to 120 miles of electric range. They like the gasoline back up with a PHEV. Participant 2064 chose an ICEV but said, “The plug-in hybrid is the best of both worlds to me” and “The electric car offers the potential of the future.” They like the idea of a PHEV with 50 miles of electric range because they can charge at home and switch to gasoline only in an emergency.

2. Respondents who can’t Imagine Owning a PEV or FCEV

Some interviewees were unable to imagine, uninterested in imagining, or unconvinced in their imagination, of owning a PEV or FCEV; they were certain such a vehicle was not for them or their household. They discussed what they know and don’t know about these vehicles, including types available, the technology itself, refueling options, and available incentives. They talked about their motivations against, such as range limitations and safety concerns. This section concludes with details on how they ultimately did not design a PEV or FCEV.

What do they know about PEVs and FCEVs?

Vehicle Types and Technology

These participants had no to little knowledge of PEVs and FCEVs. A few were familiar with the names Volt, Tesla, and Leaf but weren’t sure how they differed from a Prius. Participant 250 understood the technological differences between HEVs and BEVs but only knew that FCEVs were “different,” but not how. Participants 4940 and 250 started paying attention to FCEVs after completing the survey. Most said they had had no access to information on PEVs or FCEVs. Participant 250 explained,

> “There’s just so many things you don’t know and there’s really not a lot of good information about it out there.”

Not every survey respondent had their attention turned by the survey; for example, Participant 1606 didn’t know the difference between HEVs, PHEVs, and BEVs and didn’t care to learn.

Refueling

The primary concerns of these participants regarding refueling focused on finding, or having to find, public PEV chargers or hydrogen fueling. Participant 4940 questioned,

> “Can I go down to Death Valley like I’m going to do next week? You know, how do you get places? So even if it’s [chargers] available right in your neighborhood, can you go any place else?”

They weren’t sure how long it takes to charge and didn’t know charger locations or if the chargers would be available.

In addition to the issues around away-from-home charging, the impossibility of—or even questions about—home charging was the reason for many interviewees disinterest in PEVs. Participant 4054 would not be able to charge at home because her condominium’s owners association does not have an outlet available for her to use so her main concern was charger availability,

> "What if someone just parked their car at the charging station all day…hogged it the whole day. I would be concerned about that sort of thing."

If charging a PEV was largely unknown to these respondents, none of them knew about fueling a vehicle with hydrogen.

Incentives

Several participants knew nothing of incentives available to PEV and FCEV buyers and drivers. A few were familiar with the HOV stickers; they had seen them on some vehicles. However, as you would imagine from a group that can't imagine a PEV or FCEV for themselves, the HOV-lane access was not particularly motivating. Some said they would be interested in whatever incentive was worth the most money. Only one participant had a vague idea of tax incentives and wasn't sure if it was from the "state or the dealership."

Neither use incentives such as HOV-lane access nor financial incentives addressed some participants' reservations about BEVs. Participant 4940 said that no incentive would be worth the safety issues she associates with BEVs; if BEVs met her safety standards then incentives would not entice her to buy a BEV unless it had a reliable range, though she didn't say what that would be.

Of this group of people, Participant 1606 knew the most about incentives and was vehemently against them,

> "I sort of resent that the government…why should I be subsidizing someone who buys…I assume a Tesla costs $80,000 plus…if someone could buy that car why should the government be giving them $7,500 dollars?"

They went on to say that incentives are the government engineering what's best for Americans and thinks the market should decide pricing.

Barriers and motivations against ZEV purchase

These participants had a long list of barriers that prevented them from considering a ZEV. For many, driving range is a major problem and they believe a BEV would not meet their needs for long trips and even some daily driving. Participant 4940 related an account from a friend regarding range anxiety,

> "I have a friend who has a Leaf and she is in constant anxiety about whether she is going to get to where she needs to go."

This group also worries about charging, home and away. Some are unable to install a charger at their home; others imagined the additional expense of doing so. Participant 4940 imagined it would be expensive to buy the car and to install a charger,

> "It would be a hassle to have to deal with the plug-in and it would be certainly more expensive because not only are you paying more for the car up front but then you'd have to pay to install the plug-in at your house."

Some believed there aren't enough public chargers to ensure they would be able to charge when needed, as participant 2610 explained,

> "I would probably start panicking. Do I have enough [range] to get back and forth to find a facility?"

Many were uncertain of PEVs because they had too many unknowns about the vehicles and the technology. They wanted to know if PEVs are really environmentally friendly. Participant 4347 articulated,

> "Now they are becoming popular and trendy but are they really saving energy? That's where I have a big question. We are trading one energy for another energy."

They also wanted to know about the environmental impact power plant emissions battery recycling, and hydrogen production.

Some wanted more incentives, an SUV body option, or an attractive looking car. Others didn't want to have to plan their day around charging, thought the return on investment was too long, or were unwilling to drive a vehicle without a spare tire onboard. A few participants admitted they knew nothing about PEVs or FCEVs and therefore had no interest in purchasing one. Some said the technology was not proven and they weren't willing to go first. Participant 4054 said,

> "I'm not the first person to buy something."

Specific to FCEVs, a few participants were worried about safety during an accident. Participant 250 said,

> "To be honest, when I first heard 'hydrogen' I'm thinking atomic bomb or something…I don't know if I want to drive a car with hydrogen."

Motivations for ZEV purchase

Despite their overall negative valuations or simple lack of interest, many of these participants identified positive motivations for PEVs or FCEVs. Some like the idea of using less gas, mostly for geopolitical reasons. Participant 2610 said,

> "It feels like we're going into the electric and hybrid way of doing things and we're trying to do away with gas because it fluctuates so much. And we're always fighting over gas."

Others liked the idea of using less or no gas for environmental reasons. Participant 4054 explained,

> "It's more environmentally friendly. It's what we should be doing…I like to be a little green. Not real, real crunchy but, you know, a little bit."

One participant thought it might save them money.

Another illustrated how for some of these people, it was less a lack of interest on their part than a constraint imposed on them by other conditions: nothing would motivate them to buy a PEV unless they moved to a location where they could charge one at home.

Specific to those few who expressed some interest in FCEVs, participant 4940 was curious about them in general and participant 250 was interested in how the home fueling station would work.

ZEV Designs

None of these participants designed a PEV or FCEV in any of the design games. Participant 4054 looked at the PHEV options but ultimately decided they did not have enough range and chose an ICEV. Participant 4940 chose an HEV but would not choose a PEV because of a lack of range, concern over safety in an accident, and their insistence a vehicle must have a spare tire onboard. Participant 250 chose an ICEV because they had too many concerns about FCEVs and thinks PEVs cost too much. Participant 4557 chose an ICEV because they didn't want to have to look for a charger. Participant 1606 explained in the interview that they would be open to a PHEV if there were enough charging stations—which to them means similar to gas station availability—and a range of 300 miles.

3. The Lure and Lore of Tesla

Despite no direct questioning about the company, more than half of the participants interviewed in California talked about Tesla. The brand proved to be well known among California drivers, as one participant stated, "Tesla is a pretty obvious car to see." – Participant 889. Familiarity with this brand ranged from having heard of it to having visited the showroom and taken a car for a test drive. Several participants revealed their desire to own a Tesla saying for example, "My top priority car would be a Tesla…" and "I would like to have a Tesla, I just think they're beautiful cars." – Participant 2710

Some participants explained the attraction of Tesla is aesthetic and symbolic. According to these interviewees, the Model S represents a sexy, cool, and impressive car. The lure of Tesla arises from personal enjoyment of this aesthetic but also from the act of conspicuous consumption and the symbolic message communicated to others by owning and driving the car. For example one participant said, "it's a cool thing, it's a status thing." – Participant 2864. Another participant (2710) told a story of her granddaughter running up to a Model S in a parking lot and telling her grandmother that she "just wanted to say she touched a Tesla." Participants talked about this aesthetic and symbolism in comparison to other ZEVs. For example, participant 4731 asserted that compared with other ZEVs the "[Tesla] is the awesome one… it's the hip new thing." Even those who have purchased other PEVs make this comparative judgment. Participant 1565 bought a Chevrolet Volt. As she explained the reasons behind her purchase of the Volt she said,

> "It's not that the Volts are super sexy, as the Tesla's are...."

Like many objects of desire, the motivations for that desire can be difficult to describe. For example participant 6456 said,

> "I'd like to own it one day. I mean it sounds like a pretty cool car… I really don't know what the technology behind that is… so, you're right why would that be… I really don't know."

Several participants claimed the draw of Tesla came from the combination of technology, speed, and range of the Model S. One participant (3823) stated,

> "I've looked into Tesla, which is top of the line. It's very expensive, incredibly reliable. It's got great reviews. I think what they've done is amazing."

Another participant, 4255, noted

> "[The] Tesla is a pretty amazing car for what you're getting. I mean it's just fastest… and it's pretty much dead silent. And the range is pretty impressive too."

Every respondent who talked about the Tesla mentioned the high price of the Model S. Interestingly only one participant connected the expensiveness of the Model S to the symbolic appeal of the car. Instead most participants declared the cost a barrier to their purchase of a Tesla. Although the Model S was the first choice for a BEV, the price forced them to consider other BEV models instead. Participant 217 clarified his position stating,

> "Supposedly Tesla's coming out with a model that's going to be in the 30-40 thousand dollar range. Which is going to be great, so I would really look at that as my first choice. But right now currently I would look at the Nissan Leaf, which is a little more affordable."

Participant 1565—who owned a Volt—explained that her first choice also would have been a Tesla but that she purchased a Volt because the Model S was out of her price range.

Several participants talked about how, in their opinion, Tesla represented an important force in the market, changing the image and perception of BEVs. These participants all described the pre-Tesla perception of BEVs as not fun to drive, slow, ugly and having a very limited range. Participant 5871 explains

> "I mean the complaints about electric cars. 'They're slow', well the Tesla sure isn't slow. 'They're heavy,' yes they're heavy but you can get 350 miles on the charge now on the Tesla."

Another participant believed Tesla "giving away" their patents was a smart move because it may increase market scale, acceptance of BEVs, and draw people to higher end models of BEVs. For these people, Tesla's brand and its CEO Elon Musk represent something more than just a car company but a movement or striving for something more than profits. Participant 3823 applauded the success of Elon Musk's mission,

> "I'm really in awe of the owner of the company. I think he's done a wonderful service to the economy, to our environment and whatever." In contrast, others believe Tesla has a vision but are not convinced that it will be able to achieve it.

4. Frequently Asked Questions

The majority of questions came from participants with very little experience with PEVs (or FCEVs) but who showed interest in purchasing one, participants who had experience with HEVs but relatively little experience with PEVs, and participants who had some knowledge and experience with PEVs as a result of their career or a prior interest in purchasing one. People who knew a lot about the PEVs and people who expressed very little interest in personally owning a PEV tended to have few or no questions. Many of the drivers had the same questions regarding PEVs. The question types ranged from general questions about costs, refueling, maintenance, and range to more detailed and specific questions regarding incentives, available models, battery recycling, and the direction of the market.

A very small number of individuals asked specific questions about FCEVs. These individuals were either from Southern California or had exposure to FCEVs through their work. Those that did ask questions wanted to know about the safety of fueling with hydrogen, fueling availability, and the environmental impact.

For BEVs participants generally asked about range, purchase price of the vehicle, the cost to charge, if BEVs and electricity are really better for the environment compared to internal combustion cars and gasoline, and the safety of BEVs. Three quotes from different interviews illustrate the commonalities among the questions posed by participants—and how one question about PEVs is often only the opening to a litany of concerns. Participant 889 enumerates his concerns with ZEVs and at the same time turning large imagined improvements in driving range into a new imagined set of problems,

> "Let's say somehow, somebody comes up with a great new battery that holds a charge for 400 miles. Well that's fine but then if when I plug it in is it going to take 48 hours to recharge it? And then also how much electricity is that going to take? Is it suddenly going to double my electricity consumption because I'm plugging in my car every night, you know that's a big deal. And then it becomes how much does that cost. Not necessarily in a financial way but also in convenience and time."

Participant 126 states,

> "The biggest question I would have is how available are the plug-ins."

Then, without pause goes on to add,

> "How much time is it going to charge when I do go to a stop? And how much is it going to cost, is it going to save me anything in the long run? That's going to be a real important question for me.

Then closes the list with what is possibly the most general statement of concern possible:

> "And what can go wrong?"

Participant 2610 asks,

> "Is it worth it to buy this car for that price… does the maintenance affect it more than this one… I would weigh all these things."

Then states,

> "If I was interested, I would look into it."

Questions about charging and charging infrastructure came up frequently. Participants wanted to know where they would find chargers in their localities and if there was charging available outside of metropolitan areas. Most of the participants expressed concern about finding charging stations. For example, participant 3093 said,

> "Probably my biggest thing would be knowing I have a place to recharge. That would my biggest worry. Okay, do we have a place to charge this thing? That's why when I think about maybe taking a long trip. I'm just thinking, okay where would we get this?"

Charging etiquette emerged as a concern for some, especially as they contemplated a growing ZEV market and volume of drivers in relation to charging stations. Participant 4054 voiced concern asking,

> "Would those charging stations be open? What if someone just parked their car at the charging station all day and used it. If there were two charging stations and someone hogged it the whole day. I would be concerned with that sort of thing."

Participants asked questions about the long-term upkeep of PEVs and the cost of buying and maintaining the car. Many expressed their lack of knowledge regarding the operating needs and costs of a PEV as opposed their familiarity of the maintenance needed for a gasoline car. Participant 750 articulated this uncertainty,

> "There's just so many things you don't know and there's really not a lot of good information about it out there. Who's going to fix it? Who knows how to fix them?"

Participants also offered solutions to their lack of knowledge. Participants suggested driving a PEV for a period of time would allow them to see how a PEV would fit into their life and thus might reduce or eliminate many of their reservations. As participant 2710 states,

> "Talking is one thing but to actually get behind a car and drive it. I think will answer a lot of questions."

A common sentiment that emerged as the participants discussed their questions about PEVs was that existing PEV owners offered the best source of answers and information. Participants believed that speaking with drivers could dispel a lot of their concerns and questions. One participant explained how speaking with drivers could solve the unknown, untried element of PEVs. In particular several expressed a desire to wait and speak with PEV drivers in the future about the longevity of PEVs both in the sense of their permanence in the market and the durability of the vehicles themselves. The interviewees imagined these hypothetical future PEV drivers could reliably and honestly answer questions about their cars. Participants also discussed the importance of seeing a plan for the future of the market, in particular the standardization of technology and the location of charging infrastructure.

5. Are PEVs (and FCEVs) the Future?

Nearly all of the participants interviewed talked about PEVs in relation to the future: the future of the automobile market, the future of PEV technology, and the future in an environmental context. This quote from participant 3823 summarizes the general belief among participants that PEVs would play important role in the future of automobiles,

> "That's where I think the industry is going. I think anyone who is buying a conventional or gas car these days is not very farsighted. From an economic, from an environmental, from a lot of perspectives… well from a selfish perspective its gas consumption…"

Through narratives of their mobility needs and imagined PEVs, participants described what the future of PEVs meant to them. When talking about an imagined future for PEVs and FCEVs people talked about improvements in technology, increased charging infrastructure, more fuel cell vehicle availability, and more public discourse around PEVs and FCEVs. Speaking to his belief that technology will continue to improve and progress participant 2189 said,

> "That is where the future will go eventually. The future, and I truly believe this, is in electric engines. They are getting smaller and more efficient and they're being produced in greater and greater numbers. That's going to be the future."

According to several participants, in the future the automobile industry will move toward producing PEVs rather than gasoline vehicles. Participant 3823 stated,

> "Five years from now. That's predicated on my extrapolating to where the industry is going based on what I see now. I would say, the electric, the all-electric the Tesla… type. Rather than the hybrid. I think gas will be somewhat obsolete and will not be as cost effective."

For Participant 889, ZEVs represented an inevitable, global future for the automobile industry. He said,

> "I think this is pretty interesting stuff. It is a place that we as a country, and the world, are moving towards. And we need to figure a way to get there, one way or another, before it's forced upon us."

Participant 5871 was less convinced,

> "I think it's the future, I hope it's the future. It may not be, but I hope it is."

In general most participants who spoke of the future expressed some level of belief that transportation would become more reliant on electricity because reliance on gasoline was proving to be problematic on a social and/or environmental level.

In their narratives participants declared that PEVs would no longer be a novelty when garbage trucks and work trucks run off electricity and charging is as easy, convenient, and familiar as filling up on gasoline. They claimed that the increasing number of PEVs they see on the road indicates the reliability of the vehicles and increasing popularity among drivers as a result of this reliability.

> "Once I start seeing more of them on the road, or I start seeing advertising for more hydrogen vehicles then I would seek out more information." – Participant 250.

Participant 2112 also believes that

> "So if we're headed in the direction I think we're headed in the future with vehicles… we're eventually going to have electric vehicle everywhere."

According to several participants the lack of familiarity with PEVs and FCEVs and the unknown elements of long-term reliability, maintenance, and lifestyle fit represented the biggest obstacles to uptake. Some predicted, drawing on the example of hybrid vehicles, that in several years adoption rates would increase exponentially as people became familiar and comfortable with PEVs and FCEVs. Some participants stated that they personally were waiting for further developments to occur before they would be comfortable purchasing a one. This group believed that the majority of consumers felt the same way and wanted to see the technology progress before they committed.

Many of the participants expressed a belief that PEV and FCEV technology would continue to improve and progress. They spoke of waiting for the next vehicle generation or talked about revisiting the idea of purchasing a PEV or FCEV once the technology was proven, or had been tested. There was a general, shared lack of interest in what participants designated as the first generation. They expressed this reluctance in several ways. Participant 3823 stated,

> "I think state of the art is not there. But things like everything else are evolving. I just don't want to be on the bottom. Learning from their mistakes. I don't believe in being a guinea-pig."

Another (2864) explained,

> "I'd rather let someone else ride out the bugs because first year cars always have something wrong with them. So let someone else work through the bugs… inevitably there is always something wrong in first generation models."

A third said,

> "I don't need to be the guinea pig for Toyota or Honda figuring out a new paradigm." – Participant 4222

Most of these participants, though hesitant to purchase a PEV or FCEV now expressed a strong interest in owning one in the future as the technology improved.

A number of people interviewed believed that PEVs and FCEVs would become popular with younger people because they are more modern, liberal, and open to change. One woman (participant 4054) said,

> "I would think that people in my building would be interested. I mean, there's a lot of young people. There's a lot of students."

Another woman endorsed PEVs but explained that she felt herself to be too old and too set in her ways to make the switch from a gasoline vehicle.

When discussing the transition from ICEVs, participants frequently contemplated the PHEV as a stepping stone or transitional stage in personally adopting a fully electric vehicle. For example, 3142 stated,

> "I would rather try a plug-in hybrid first and then see how comfortable I was with it and how it worked. And then maybe move into an electric car after that."

Many other participants shared this sentiment, explaining how a PHEV would allow them to adjust to the differences presented by BEVs. Not only did participants express a desire to see if an BEV would fit into their life they also considered how they might change their driving behavior to move away from gasoline vehicles. The following two quotes summarize the general opinion on plug-in hybrids.

> "Both the hybrid and the plug-in hybrid are sort of like temporary technologies where you're trying to figure out how we can increase the range of an electric vehicle to a point where people want to drive 300 miles or 600 miles in a day, they don't have to worry about it." – 2189

> "Because then you would get used to knowing you've got to charge the car but yet you've got your gas back-up. So it would get you started on an electric car without going all electric." - 2710

For some participants PEVs and FCEVs represented the future in that their production and adoption demonstrated a conscious action to address future environmental issues in the present. One participant, 2064, expressed her enthusiasm this way,

> "I love the promise of the fact that we can help potentially preserve mother earth for our future generations. That's what I love."

Another participant (2628) explained,

> "…because we're both interested in the environment. As far as CO_2 emissions goes I think it's a very serious threat. Not only in the near future but especially in the decades to come. So anything that we can do to help mitigate that I think would be beneficial."

This environmentalism emerged as a common current among diverse participants, even those who did not see themselves as "green" or particularly concerned with environmental issues. For example, participant 3142 explains:

> "I think because we use… I mean there are so many vehicles and the way that we are going, I mean the future isn't going to have fossil fuels or natural resources are going to be drained because of how we drive and how much we consume. Any little bits that we

> can do would help. I mean I’m not a full green person where I’m like I have to do this and it has to be… but I mean if you can I mean we can prevent limiting and depleting all of our resources we don’t want to do that. And electric is something we can renew, something we can actually make and generate… and same with hydrogen…”

For many participants PEVs represented an achievable means of addressing limited resources and the negative environmental effects of vehicle emissions. At the same time many of these same people expressed concern about the environmental issues connected with energy production, sources of hydrogen fuel, and battery production and recycling. Participants presented these concerns as problems that would need to be solved rather than barriers to the future environmental benefits of PEVs and FCEVs.

DISCUSSION

Part of the overall framework for this study was to trace consumers through awareness, knowledge, and valuation of PEVs and FCEVs. A valuation—does the respondent think there is a PEV or FCEV they would buy for their household's next new vehicle—does not have to be based solely on knowledge, e.g., understanding PEV and FCEV technology, supporting infrastructures, social goals, and private performance attributes. A valuation does not have to be based on accurate knowledge, but can be based on what the respondent thinks they know, whether their "knowledge" matches that of other consumers, engineers and designers, policy makers or other experts. A valuation likely does depend on awareness—consumers are unlikely to form valuations of things of which they are unaware. Following from this, the vehicle design games are not an attempt to estimate market demand but to explore new car buyers' present valuations of PEVs and FCEVs—no matter how imperfectly formed—and to understand whether and how those present valuations can be affected.

The design of a plausible next new vehicle for the household was the primary measure of respondents' valuations. Among respondents in California, 38% designed a PHEV (21%), BEV (11%), or FCEV (6%) in the final design game. The final design game differs from the first and second games in that it eliminates the possibility to design a vehicle with battery-powered all electric-drive (PHEVs with all-electric charge depleting operation and BEVs) in full-size body styles but adds incentives for PHEVs, BEVs, and FCEVs modeled on those available at the time of the survey. Though modeled on available incentives, the "design game world" incentives differ from real-world incentives in that anyone designing a qualifying vehicle receives the equivalent of the present federal tax credit, but they must chose only one of the other available incentives. At the time of this study, in California buyers of qualifying vehicles are eligible for multiple incentives, e.g., an additional vehicle purchase rebate and single-occupant vehicle access to HOV lanes (depending on availability).

Combining the drivetrain percentages from this study with data from another contemporaneous survey of all car-owning households in California, as well as data from the most recent US Census and American Community Survey, produces an estimated nearly 1.5 million California new car-buying households would want their next new vehicle to be a PEV or FCEV. It would be premature to conclude these estimates represent immediate vehicle sales. It would be equally premature to dismiss them as "just what people say, not what they would do." Rather, they indicate that even in a (real) world characterized by low levels of general awarness of PEVs and FCEVs, lower levels of experience with such vehicles, scattered and limited availablity of PEVs (and essentially no availability of FCEVs), consequential numbers of households want their next new vehicle to be a PEV or FCEV—at least as they imagine such vehicles within the (abstract) world of the survey.

The mission of anyone interested in promoting PEVs and FCEVs is to satisfy those abstract desires in the real world. To do so requires understanding why some respondents want PEVs or FCEVs, why still more do not, and what distinguishes the abstract world of the survey design games from the real world. The authors contend vehicle prices are not so different—the unincentivized prices in the first game(s) do not underprice PEVs. FCEV prices are more speculative, but so to are the vehicles themselves at the time of this report. As far as the incentivized prices are concerned, by far the largest financial incentive—the federal tax credit—

is available everywhere. There is far greater variety of PEVs and FCEVs in the survey; we have essentially assumed away any differences that desires for speific makes and models would make by allowing respondents to stipulate any make-model (except for the size restriction imposed on battery-powered all-electric drive in the final game).

Lack of awareness, knowledge, and experience

In California—where PEVs had been for sale for more than four years at the time of the on-line survey—the results of this research indicate a lack of general consumer awareness of availability is the first problem to be overcome to expand ZEV markets, followed immediately by aiding consumers to learn what it is they don't know about ZEVs (or to unlearn what they think they know but is factually incorrect or otherwise different from what their knowledge would be if based on actual experience).

Name recognition of the available BEVs is low: 35% of respondents in this sample of new-car buyers could name a BEV—and more than 90% of those respondents name one of only two BEVs. A judgment commonly expressed in follow-up interviews was that one of those BEVs was too expensive and the other was not stylistically to many peoples' liking. If those are the only two vehicles that are widely known, how would consumers value BEVs if they knew of the dozen or more other choices they had at the time they completed the survey?

An examination of wrong answers to naming BEVs indicates respondents aren't distinguishing between types of PEVs, i.e., between PHEVs and BEVs. At this early stage, it may seem picky to disallow valid names of PHEVs as answers to the question of naming an BEV, but the inability of consumers to distinguish BEVs from PHEVs—and PHEVs from HEVs—speaks to the core problems of measuring familiarity and distinguishing what people know from what they think they know about PEVs and FCEVs. The distinction between charge-depleting modes of PHEVs—all-electric operation (see for example, BMW's i3 with range extender) vs. assist (see for example, Toyota's Prius Plug-in)—is another source of profound confusion. While this confusion can only be inferred from the survey data, the follow-up interviews add supporting insights. Interviewees were routinely confused by the differences in operating modes of PHEVs; some had avoided "all-electric" operating modes for PHEVs in their design games because they believed they would be stranded when the battery discharged. Others had avoided any PHEV in favor of an HEV for the same reason.

In general, the assertion that respondents are unfamiliar with ZEVs is supported by the averages of their self-ratings (on a scale from -3 = unfamiliar to 3 = familiar) of their familiarity with ICEVs (2.37), HEVs (1.70), BEVs (1.35), PHEVs (1.07), and FCEVs (-0.37). Not only do their familiarity scores drop on average as we move from start to finish of this list, but the percentage of people even willing to offer an answer declines too. The assertion is further supported by respondents' limited or absent driving experience (measured on a scale -3 = none to 3 = extensive) with HEVs (-1.14), PHEVs (-2.10), BEVs (-1.97), and FCEVs (-2.28). Finally, the assertion is further supported by respondents' answers to whether they had already considered buying a BEV or FCEV: 78% of this sample of new car-buyers indicates that prior to the survey they had not given any consideration to PEVs; for FCEVs, the figure is 91%.

The effect of familiarity and experience on valuation is signaled by the presence of several measures in the logistic regression model of drivetrain types in the final design game. A component measuring familiarity with HEVs, PHEVs, BEVs, and FCEVs and a second measuring familiarity with ICEVs both are retained in the model. This broad array of measures indicates that both general familiarity with automobiles and a specific interest in electric-drive and zero-emission vehicles are important. Similarly for direct driving experience, a component specific to PHEVs, BEVs, and FCEVs as well as another pertaining to driving experience with HEVs affects ZEV valuations, i.e., the drivetrain types in the third game.

Pre-Survey PEV-related Evaluations

Despite the low incidence of familiarity and experience—compounded by the limited opportunity to buy PEVs (and even more limited opportunity for FCEVs) because of their recent and partial introduction to retail markets—a small percentage of respondents claim to have already started to search for information (15%), perhaps already visiting a dealership for a test drive (5%), or even acquiring one for their household (3%) for PEVs; for FCEVs, 7% have started to gather information. These prior evaluations—for both PEVs and FCEVs—are important explanatory variables for PEV and FCEV valuation.

The concept of government incentives for alternatives to gasoline and diesel is important to respondents' drivetrain designs, though the concept does not enter the multivariate model of drivetrain designs as simple awareness of incentives. The concept enters as the belief whether governments should offer such incentives. A majority of the sample (56%) believes governments should, "offer incentives to consumers to buy and drive vehicles that run on electricity or hydrogen." (The survey instrument allows respondents to choose whether incentives should be offered for neither, either, or both, or to state they are unsure.) A higher percentage of the CA sample, (~50%), claim awareness of federal incentives than the average across the study states. Awareness of CA state incentives (33%) is much lower than for federal incentives, but twice that for any other state.

Other concepts important to respondents' PEV and FCEV valuation include whether they believe electricity is a likely replacement for gasoline and diesel and whether they personally have an interest in PEV and FCEV technologies. Majorities of the California sample believe electricity is a likely replacement for gasoline and diesel (61%) and express interest in the technology (55%). California respondents are among the most likely in any state to indicate they have seen PEV charging in the parking lots and garages they use (exceeded only by respondents from Oregon).

Other measures of the respondents' consideration of PEVs and FCEVs prior to their completing the on-line survey enter into a multivariate model of respondent valuation of such vehicles, i.e., respondents' drivetrain designs in the third vehicle design game.

1. It matters whether respondents already believe that electricity and hydrogen are a likely replacement, "if for any reason we could no longer use gasoline and diesel to fuel our vehicles." Those respondents who choose electricity as a likely replacement for gasoline and diesel fuel are estimated to be more likely to design their next new vehicle as a BEV (and less likely to design it as an ICEV or HEV). Prior belief that hydrogen is a likely replacement is associated with a higher likeliness of designing an FCEV.

2. Respondents' prior assessments of the comparative safety and reliability of PEVs and ICEVs is associated with their valuation of ZEVs. The more strongly respondents believe PEVs are more reliable and safer than ICEVs, the more likely they are to design HEVs, PHEVs, and BEVs.
3. Regardless of whether respondents' self-scored familiarity with ZEVs is based on a solid factual understanding or experience, those familiarity scores are associated with the vehicle designs respondents create. Those who claim a higher familiarity with HEVs, PHEVs, BEVs, or FCEVs are more likely to design something other than an ICEV.
4. Those who have already given any consideration to the question of buying a PEV are estimated to be more likely than those who have not to design their next new vehicle to be a PHEV or BEV.

Identifying which ideas about and assessments of PEVs and FCEVS create more positive valuations may rely on more specific prior assessments of ZEVs. Three components of such prior vehicle-specific assessments are in the model of drivetrain designs, two pertaining to PEVs and one to FCEVs. For PEVs, one component is associated with the relative safety and reliability of PEVs compared to ICEVs. The more reliable and safer PEVs are judged to be in comparison to ICEVs, the more likely the respondent is to have designed a PEV. Respondents' assessments of PEV safety and reliability may be determined by perceptions of electricity and gasoline per se, in addition to or even instead of, the vehicles.

The other two components pertain to the same attributes of both PEVs and FCEVs: driving range and charging/fueling time. The more negative the assessments, i.e., the more strongly respondents agree with statements that these vehicles' range per charge or fueling is too short and it takes too long to charge/fuel them, the less likely they are to design one of these vehicles. For FCEVs in particular, aiding new car buyers to distinguish BEVs from FCEVs on the attributes of driving range and fueling time may be helpful. It also serves as another example of how new car buyers have not yet considered PEVs and FCEVs seriously enough to understand the similarities and differences.

Since the measures of respondents' assessments of PEV and FCEV driving range and charging/fueling times are not tests of objective knowledge but rather statements of agreement or disagreement about distances being "not…far enough" and times being "too long," these measures are formed in response to the respondents' own expectations and situations. Analysis of the driving ranges of BEV and FCEV designs in Game 3 as well as the corresponding components scores highlight this distinction between judging whether a perceived driving range is "too short for me" vs. knowing the driving ranges of different BEVs and FCEVs. Among those respondents who design an FCEV in Game 3, whether they agree or disagree that FCEV driving range is too short and fueling time too long before they play their design game is not associated with the driving range they incorporate into their FCEV design.[37] For those who design BEVs there does appear to be a relationship: those with lower component scores, i.e., those who disagree BEV driving ranges are too short and charging times are too long, are more likely to

[37] The Prior FCEV Component for driving range and fueling time is associated with the probability a respondent designs an FCEV. A test for a bivariate correlation between the component scores and the driving ranges of the FCEV designs is not statistically significant.

design BEVs with shorter driving ranges than are those with higher components scores, i.e., those who agree BEVs' driving range is too short and charging time too long.

Motivations to Design PEV and FCEVs

What we have called motivations for and against PEVs and FCEVs are different from the variables correlated with drivetrain types in that motivations are assessed after the respondents have created and selected their next new vehicle. In this sense, the questions about motivations are less about inferring what matters to respondents through the exploration of statistical correlation than they are a challenge to the respondent to explain their design game results.

Motivations for designing a PEV or FCEV that scored highly across the sub-sample of people who did design one include:

- To save money on gasoline or diesel fuel;
- I'm interested in the new technology;
- It will reduce the effect on climate change of my driving;
- It will reduce the effect on air quality of my driving;
- It will reduce the amount of oil that is imported to the United States;
- I'll pay less money to oil companies or foreign oil producing nations;
- It will be fun to drive; and,
- It will be safer than gasoline or diesel vehicles.

These after-the-fact explanations for designing a PEV or FCEV indicate both social goals and private performance attributes motivate some consumers. A personal interest in ZEV technology, personal affect on air quality, and the comparative safety of ZEVs and ICEVs are directly reflected in the model. The most highly rated motivation has some respondents switching from gasoline to electricity to take control over specific types of spending. Gasoline costs—being ongoing and uncertain—may be accounted for differently than vehicle purchase costs.

Additional insights are gained by examining clusters of respondents who share similar motivations. The most striking finding is a distinction between two clusters who say they were strongly motivated to design a PEV or FCEV by public policy issues such as air quality, climate change and energy security, (the "Pro-social technologists" and "Thrifty environmentalists" in Figure 30), and a third cluster who claim very little pro-social motivation, (Private hedonists). The existence of these first two clusters may not be a surprising result, but the third scores highly only on motivations of private cost (expecting fuel and maintenance cost savings), a personal interest in ZEV technology, and a belief a ZEV can be a fun, comfortable, safe, good looking car that makes the right impression on family and friends. The distinction between the two pro-social groups is the depth and breadth of their pro-social motivation and the much greater interest in costs by "Thrifty environmentalists" than by "Pro-social technologists."

It is worth noting that the clustering algorithm assigns respondents to clusters probabilistically. That is, there is less of a clear distinction between clusters (and thus respondents) than this discussion may imply. In this instance, it turns out three clusters share what is nearly their highest rated motivation—saving money on fuel costs—as well as an interest in ZEV technology. Appeals to broader social goals may motivate the Pro-social technologists and Thrifty environmentalists. More conventional automotive marketing messages may appeal to the Private hedonists. The smallest cluster ("Why did they design a PEV or FCEV?") spent few points in the motivation exercise (an average of about eight points compared to about 27 points by all other clusters). In general, these people have few highly rated motivations—but among them are also interest in ZEV technology, saving money on fuel costs, and increased safety compared to gasoline and diesel vehicles.

Barriers to PEV and FCEV Valuation: lack of knowledge

Aside from the lack of awareness discussed above, understanding why more people do not have positive valuations of PEVs and FCEVs—at least not positive enough to cause them to design one as a plausible next new vehicle for their household—may be more important to understand. Recall these are the top-scoring, self-reported motivations for ***not*** designing one:

- Limited number of places to charge or fuel away from home;
- Cost of vehicle purchase;
- Distance on a battery charge or tank of natural gas is too limited;
- I'm unfamiliar with the vehicle technologies;
- Concern about unreliable electricity, e.g. blackouts and overall supply;
- I can't charge vehicle with electricity or fuel one with hydrogen at home;
- Concern about time needed to charge or fuel vehicle;
- Cost of maintenance and upkeep;
- Concerns about batteries;
- Cost to charge or fuel; and,
- I'm waiting for technology to become more reliable.

Taken as a whole, this list illustrates that for many people the sheer number of questions, doubts, and uncertainties they have add up to their negative (or at least, not sufficiently positive) valuation of PEVs or FCEVs. The number of motivations to not design a PEV or FCEV that score above their global mean outnumber the motivations to design one. The prior argument about low familiarity is echoed by those who do not design a PEV or FCEV themselves; the fourth highest scored motivation for not designing a PEV or FCEV is simply "I am unfamiliar with [ZEV] technology." "I'm waiting for the technology to become more reliable" makes this list, too. This leads to the possibility that the list of barriers is itself a rationalization—a way of explaining in a seemingly reasoned way opposition to something that is simply unknown.

The list indicates important barriers to PEVs and FCEVs include charging/fueling (away from home networks, inability to fuel/charge at home, time to charge/fuel), costs (purchase, fuel, and maintenance). Solutions to home charging are likely to be specific to each situation—but amenable to general actions on codes, standards, and designs for EVSE installations. Beyond some initial threshold of away-from-home charging and fueling locations, addressing concerns about availability of away from home charging is as much about the perception of an extensive fueling network, that is, about developing and disseminating images and information about such networks as it is about the number and distribution of charging opportunities.

Costs are also amenable to both changes in present costs as well as better information about present costs and trajectories of costs into the future. Purchase costs are susceptible to reduction through incentives such as those offered in the survey (modeled on those actually offered by the federal government and different states and localities) as well as cost/price reductions by vehicle manufacturers over multiple vehicle generations.

Maintenance and fuel costs are discoverable only over time. Other barriers for which their actual measure for any individual are only discoverable over time include concerns about reliability of electricity supply, ability of an away-from-home network to provide adequate charging/fueling, and coupled with this, suitability of any particular driving range per charge/fueling. While experience might be the best teacher, the problem discussed here is people who aren't interested in accumulating the relevant experience in a PEV or FCEV. Images that make PEVs "normal" can help; the experiences of PEV drivers as related in on-line forums have been important sources of information—to those already inclined to seek them out.

The argument that the greatest barrier to these households who demonstrate a negative valuation of ZEVs is their long list of questions and concerns (more than any single question or concern) is borne out by the cluster analysis done on these respondents' motivations. Despite interpreting higher numbers of clusters to see whether other top-level ideas would distinguish clusters, a three-cluster solution is enough to show the main distinction is between one group (of about one-third the respondents) who appears comparatively unconcerned or unengaged (scoring only "unfamiliar ZEV technology" and "cost of vehicle purchase" slightly above global average of all motivations,) and two other groups who both have long lists of highly scored concerns: the two groups highly score nine or eleven (of seventeen possible) dis-motivations. It is worth noting that one of these two clusters sounds the stereotypical list of complaints—limited range, limited refueling, high purchase cost, long charging times. The other group shares their concern for limited fuel networks, but speaks more directly to an inability to charge (or fuel) at home. This second group shares the firsts concerns about high purchase prices, but their highest scored concern in simply that they are unfamiliar with ZEV technology.

Constraints to PEVs? Measuring access to home charging

Lack of access to PEV charging at home is one of the motivations against designing a ZEV that earns a higher score than the average of all motivations against. Nearly 25 percent of this sample doubt they would be able charge a PEV at home; 21% of those who don't design a ZEV assign the maximum score to the statement, "I can't charge a vehicle with electricity or fuel one with hydrogen at home." The ability to charge a PEV at home is one of the explanatory variables in the model of drivetrain designs.[38]

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[38] Respondents are asked about home charging of PEVs two different ways. First they were asked, "Given where you park at home, could you reliably access any of the following to bring electricity to your vehicle? Please choose all that apply:

- ❑ A regular electrical outlet (110-volt). These are used for most home electrical appliances.
- ❑ A high power electrical outlet (220 to 240-volt). These are typically used for electric clothes dryers, electric stoves, electric furnaces and air conditioners.
- ❑ A device designed specifically for charging an electric vehicle.
- ❑ None of the above
- ❑ I don't know."

What is not in the multivariate model of drivetrain designs?

Given the explanatory variables that are in the multivariate model of drivetrain types in Game 3, several potential explanatory variables that are correlated to drivetrain type (as described in Appendix A) do not appear in the final model. The possible interpretations of their absence include that 1) they only appear to be correlated in the absence of other explanatory variables and 2) they are correlated with drivetrain designs, but less strongly than the variables that do appear.

Measures of vehicles and travel

Measures of household vehicle ownership and travel are not in the final model of Game 3 drivetrain types for California. Number of household vehicles has long been thought to be important to—at least early—PEV market development because ownership of multiple vehicles—and a "long range" alternative to a BEV, in particular—has been imagined to be one important adaptation.

Other measures of household vehicles and their use that do not appear in the model include:

- Most recently acquired new vehicle(s)
    - Price paid for the most recent new vehicle
    - Number of vehicles acquired as new since 2008
- Vehicle the respondent drives most often
    - Monthly miles driven
    - Monthly fuel spending on the vehicle
    - Accuracy of their estimate of monthly fuel spending
    - Fuel economy
- All household motor vehicles
    - Monthly fuel spending on all vehicles
    - Accuracy of their estimate of total monthly fuel spending
- Daily travel
    - Daily variability of respondent's driving distances
    - Day-to-day variability of household's assignment of vehicles to drivers
    - Whether respondent commutes to a workplace (entirely or in part) in a household vehicle
    - HOV lane use
    - Toll facility use

Socio-economic and demographic descriptors of respondents

Home ownership may be an inexpensive and readily available proxy measure for the probability the resident could charge a PEV at home, but we can't say there are widely available proxy measures for people who are interested in ZEVs. That is, measures such as income, age, education, and gender may not be reliable indicators of interest in ZEVs—even if there exists at

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Second, a few pages later as part of a set of statements about PEVs, they were asked to rate the strength of their disagreement/agreement with, "My household would be able to plug in a vehicle to charge at home." It is the first measure that enters into the model of drivetrain designs.

present a specific socio-economic and demographic profile of the earliest PEV buyers. The absence of measures such as age, income, education, and gender from the model of drivetrain designs may have two explanations. First, the sample is limited to new-car buyers. So while not strictly a high-income sample, it is a sample of people who spend a sufficient portion of their income (or credit or accumulated wealth) to buy new cars. Second, the survey data are from a simulation, not actual ZEV sales and multivariate models control for only the effects of other variables in the model. This means that in the abstract world of the survey and model, once we have accounted for the ability to charge or fuel a vehicle at home, attitudes toward social benefits (air quality in the case of the California sample), general automotive knowledge, and direct assessments of ZEVs, ZEV "fuels" and their infrastructure, then socio-economic and demographic descriptors of people are not important to explaining who has a pro-ZEV valuation vs. who has a con-ZEV valuation.

Comparing States and Regions

While levels of respondent consideration of PEVs and FCEVs prior to the survey are low in all the study states and the NESCAUM region, respondents in California, Oregon, and Washington are more likely to have given higher levels of prior consideration to PEVs and FCEVs than those in the NESCAUM region, Maryland and Delaware. Prior consideration is higher for PEVs than FCEVs across all states.

The differences between states and regions in their distribution of drivetrain designs—and in particular between western and eastern states—is more pronounced than the differences in respondents' prior consideration. Respondents in California, Oregon, and Washington are more likely to design a PEV or FCEV than respondents in any eastern state. The range is from a low of approximately one-fourth two a high of two-fifths of new car buyers appear ready to consider a PEV or FCEV for their household. Expanding these to population level estimates, these survey respondents represent 3.34 million new car-buying households.

Comparing multivariate models

Comparing the nominal logistic regression equations estimated for California to those for the other states and the NESCAUM region reveals similar patterns of concepts are correlated with respondents' vehicle designs, even if the specific measures of those concepts differ from model to model. Almost no measures of socio-economics, demographics and political affiliations appear in any model of respondents' drivetrain designs, i.e., given the other variables that do appear in the models, these measures offer no real explanation for who presently has a high enough valuation of PEVs or FCEVs to seriously consider one for their household. The contextual measures appearing across the largest number of state and regional models pertain to whether respondents are likely to be able to charge a PEV at home. The measure of vehicle travel that appears in a few models is whether or not the respondent commutes (at least part way) to work in a household vehicle. Of the measures pertaining to ZEV policy goals and instruments, those measuring attitudes about air quality are the most common across states and regions. Notably, measures of agreement with the existence, root causes, and role of lifestyle in global warming and climate change are absent from nearly every model. In a few states, whether respondents are aware of federal incentives for alternatives to gasoline and diesel or support the idea of government incentives enter the models of respondents' vehicle designs as statistically significant.

The conceptual category that provides the most measures of respondents' drivetrain designs is the category containing measures specific to PEVs, FCEVs, electricity, and hydrogen. These measures include:

- Whether electricity and/or hydrogen is already believed to be a likely replacement for gasoline and diesel;
- Personal interest in ZEV technology;
- Familiarity with all vehicle drivetrain types included in the design games: ICEVs, HEVs, PHEVs, EVs, and FCEVs;
- Prior assessments of EVs and FCEVs on six dimensions: charging/fueling, purchase price, safety, and reliability;
- Experience driving vehicles of the different drivetrain types;
- Whether respondents have already seen PEV charging in the parking facilities they use; and,
- Extent to which respondents have already considered acquiring a PEV or FCEV.

Comparing Literatures

Numerous other studies have been made of markets for alternative fuel vehicles (AFVs). Some of these include both alternatives for combustion vehicles, e.g., bio-fuels, in addition to PEVs, and in some cases FCEVs. Studies may be focused on a state or country, a topic, or range broadly over either or both geographies and topics. The present report can be characterized as that latter. Beyond differences in spatial and topical boundaries, the literature varies as to the populations studied: licensed drivers, car owners, PEV owners, people expressing an intention to become PEV owners, persons older than a specified age, or as here, households who have purchased a new vehicle with in the few years prior to their survey responses. The literature varies as to whether total populations of people interested in AFVs or annual sales are estimated, or whether a set of influential variables affecting response to AFVs is identified.

Limiting the discussion to studies that have focused on PEVs, it is little surprise the most comparable literature to the present study is from the first author and his colleagues (Kurani et al, 1996; Axsen and Kurani, 2009; Axsen and Kurani, 2013a, 2013b; Axsen et al, 2015; Bailey and Axsen, 2015). These share a focus on new car buyers—operationalized as having acquired at least one vehicle as new with some period of years prior to the survey date. They share data collection methodology in the use of design games. The use of logistic regression to model drivetrain designs is common to these studies. While the present study uses cluster analysis to search for and explore distinct sets of respondents after the design games, Axsen and his colleagues have recently used latent class models to address the same question, but as part of the analysis of the game results themselves. Geographically, these studies have focused on regions as small as counties (San Diego County, CA), through individual states especially California, to aggregates of multiple states (in the present study), to nations, i.e., the United States and Canada (except French-speaking Quebec).

These conclusions from an older study that limited the design space options to ICEVs, HEVs, and PHEVs are indicative of a lack of increase in consumer awareness, knowledge, consideration, and valuation of PEVs during the years prior to PEVs introduction for retail sale (the data were collected from a US sample with a California oversample, in December 2008):

> "About one third of U.S. new vehicle buying households have both the required infrastructure and interest to purchase a vehicle with plug-in capabilities.
>
> "The majority of new vehicle buyers have little or no familiarity with the idea of a PHEV, and may erroneously believe that existing hybrid-electric vehicles can perform the same basic function as a PHEV, i.e., have the ability to be refueled by gasoline and to be plugged into an electrical outlet." (Axsen and Kurani, 2009

Four years later, following two further surveys that added BEVs to the design space, the same authors drew similar conclusions, even in a sample focused on San Diego County—site of both an early launch city for the Nissan Leaf and an Ecotality project area for PEV infrastructure deployment (Axsen and Kurani, 2013a, b).

From two reports on studies of new car-buying households in Canada, Axsen and his colleagues report results that echo those of this study:

> "PEV understanding is low…
>
> "Most Mainstream respondents did not know that PHEVs existed, and had trouble understanding the "dual fuel" concept.
>
> "About one-third expressed interest in some form of PEV, and most selected a PHEV over a BEV design (89-93%)…" (Axsen et al, 2015);

And,

> "…36% (n = 530/n = 1470) of respondents that designed either a PHEV or EV…" (Bailey and Axsen, 2015).

Thus studies spanning the period of the introduction of PEVs to the North American market, from locales of high early activity to broad national studies, these researchers consistently find something like one-third of new car buyers are sufficiently receptive to PEVs that offered the opportunity to do so, they design a plausible next new vehicle for their household to be a PEV. The greatest range around this proportion is found in the present study (24% to 39%), which has the greatest variety of US state-specific analyses and the most diverse vehicle design space. These studies also concur—over varying geographies and spanning from before the launch of PEV sales (December 2008) to the end of 2014—that the population of households who have shopped for new vehicles during this time period are barely aware of the increasing possibilities for them to have considered a PEV for their household.

Broadly, studies of car-buyers in other nations using different methodologies return similar results. Krupa et al (2014) general concur in their results, though as with Axsen and Kurani (2009) they limit their "AFVs" to PHEVs. Hackbarth and Madlener's (2016) study of German markets for AFVs calculates willingness-to-pay and compensating variation values for a set of AFVs that differs from the present study in its explicit inclusion of bio-fuels. Again, they find, "…about 1/3 of the consumers are oriented towards at least one AFV option…" They too identify distinct classes of motivations for consumer interest in AFVs.

The results regarding clusters or classes of respondents' shared motivations also broadly identify the sets of reported or inferred motivations for and against AFVs. Thus Larson et al's (2014) study in Manitoba, Canada highlights these three commonly reported motivations for PEVs: "…environmental image; reduced fueling costs; and technological innovation." These three are common across the consumer-PEV literature. The present study adds to this list the idea that on many of the dimensions on which consumers judge any car, some consumers expect PEVs to simply be better cars.

We would also generalize "environmental image" in two ways. First, the pro-social motivations include issues other than the environment, e.g., energy supply. Second, pro-social motivations can be about more than image—which we take to be the presentation of self (to cite Erving Goffman) to others—but may also include the expectation of an actual effect. Thus our inclusion of motivations phrased both as image, "I think it makes the right impression for family, friends, and others," and effect, "It will reduce the effect on air quality of my driving."

As in the present report, Larson et al (2014) also cite a longer list of "potential barriers to EV purchase: (1) range limitations; (2) high purchase price; (3) uncertain power and performance; (4) uncertain fuel cost savings; (5) uncertain battery life and replacement cost; (6) uncertain total cost of ownership over vehicle life; (7) uncertain infrastructure, for recharging and vehicle support; and (8) extensive time required for vehicle recharging."

We repeat our contention that the sheer length of such lists of why some people do not form positive valuations of PEVs and FCEVs is itself another dimension of such barriers. As such, purchase and use incentives fail to overcome the simple fact that the largest barrier is that so much is unknown. Purchase and use incentives appear in the present study to have the greater effect on those who already have a positive PEV or FCEV valuation.

Comparatively less published literature deals with the entire menu vehicle purchase and use incentives offered to respondents in this study. Based on the importance respondents place on vehicle purchase prices and PEV charging networks, it has been commonly inferred that reducing prices (for example by providing rebates and tax reductions as well as price reductions brought about by improved technology and manufacturing processes) and expanding charging infrastructure would be perceived to be incentives to PEV purchase. It follows that similar price and infrastructure developments for FCEVs would be perceived to be incentives.

In their research on the effect of HOV lane access to single-occupant vehicle drivers who are already PEV owners, Tal and Nicholas (2014) report "…the HOV sticker may alone be enough to prompt a purchase of a PEV for drivers who use HOV lanes extensively." Their qualifier ("who use HOV lanes extensively") is essential and is borne out by the present study. As Tal and Nicholas found within California, HOV lanes must be available to and used by a driver in order to be valued: the higher rates of selection of HOV access as the one allowed additional incentive among the California respondents in this study than in, for example, Oregon which lacks HOV lanes. Thus in California, the design game—which forces respondents to choose a "state" vehicle rebate in the amount of the CVR at the time of this study (or the equivalent amount of money for a "state" rebate for a home EVSE) or HOV access—supports Tal and Nicholas in general: some people so value HOV access, they would take it instead of an additional purchase incentive.

CONCLUSIONS

Against a backdrop of overall low awareness, poor knowledge, absent experience, and little consideration of ZEVs prior to completing the survey for this study, it was still the case that when asked, 38% of the CA respondents designed their next new vehicle to be a PHEV (21%), BEV (11%), or FCEV (6%). Expanding to a population level estimate, this sub-set of the sample of new car-buying households in CA represents nearly 1.5 million similar households in CA. This section presents the survey sample, comparing the CA sample to the contemporaneous sample of respondents from other states and distinguishing who among the CA respondents has a positive valuation of PEVs and FCEVs from those who do not, and why.

Who is in the California Sample of New Car Buyers? What are Their Prior Notions about ZEVs?

Lacking an independent sample of new car buyers in California to compare to the sample collected for this study, the present sample is compared to the total, multi—state sample of new car buyers collected as part of this research.[39] Those other states are Oregon, Washington, Delaware, Maryland, and the NESCAUM-member states New Jersey, New York, Massachusetts, Connecticut, Rhode Island, New Hampshire, Vermont, and Maine.

On socio-economic and demographic measures including respondent age, gender, education, employment status as well as home ownership, number of people in the household, and household income, the CA sample was very similar to the total sample. One notable difference was a much higher percentage (71%) of the California sample indicated they park at least one household vehicle in a garage or carport attached to their residence than the aggregate of all other states (56%). This may contribute to the California sample's small but statistically significantly higher average rating of their ability to charge a vehicle at home (0.87, on a scale from -3, strongly disagree to 3, strongly agree) than all other states combined (mean score, 0.67).

Half of CA respondents' households (48%) own two vehicles and 65% own two or more; these figures are similar to the total sample (48% two vehicles; 63% two or more). The "age" distributions of these recently acquired vehicles—whether measured by the model year or year acquired—were similar for CA and the total sample. The distributions of self-reported vehicle purchase prices were higher in the CA sample than in the total sample: the median difference was ~$1,500. The vast majority of these vehicles were fueled by gasoline (CA 95%; total 96%).

Three-fourths of the CA sample (73%) reported they owned their home, 26% rented, and approximately 1% leased or had some other arrangement. These matched the total sample percentages. Approximately seven-in-ten of CA respondents reported their residence was a single-family home. Taking ownership and building type together, 61% of all CA respondents lived in a single-family residence they owned. Most apartment-dwellers rented their residence;

[39] As discussed briefly in the Method's Chapter section on sample representativeness, the comparison of weighted to unweighted results from this sample is another form of test for sample representativeness since the weights were derived from an independent sample. The choice to present unweighted results throughout this report was based on the lack of significant or substantive difference in tests of several estimates and distributions.

about one-half of those who lived in townhouses, duplexes, and triplexes rented. These multi-unit dwellings have been problematic markets for PEVs as their residents may not have access to a regular, reserved parking spot and be reluctant—or may lack authority—to install electrical infrastructure to charge a plug-in vehicle.

In general, several concepts may be related to whether respondent had a positive valuation of a ZEV as a plausible next new vehicle for their household. Among such concepts, these were measured in the survey:

- Likely replacements for gasoline and diesel fuel, in the abstract;
- Attitudes toward energy supply and security, air quality, and global warming and climate change;
- Prior familiarity with the specific technologies that will be explored in the design games, i.e., HEVs, PHEVs, BEVs, and FCEVs;
- Comparative risks of electricity and gasoline to the environment and human health;
- Prior knowledge of the availability of incentives and belief whether the public sector should offer incentives; and,
- General interest in new technology and specific interest in "the technical details of vehicles that run on electricity or hydrogen and how they work."

In California, a substantial majority—greater than the majority for the total sample—selected electricity as a likely replacement for gasoline and diesel. Most common reasons given by both samples include it has "already been proven to be effective" and "it is best for the environment." Californians were more concerned about air pollution and more likely to agree individuals can affect it compared to the total sample. On average, this sample of new-car buyers in CA was far more likely to agree with the statement, "Air pollution is a health threat in my region" than is the total sample: the mean score on the scale of -3 (strongly disagree) to 3 (strongly agree) is 1.06 in CA and 0.53 for the total sample ($\alpha \leq 0.05$). Further, the CA sample was on average more likely to agree with the statements, "I personally worry about air pollution," (1.15 vs. 1.02, $\alpha \leq 0.05$) and "Air pollution can be reduced if individuals make changes in their lifestyle" (1.74 vs. 1.67, $\alpha \leq 0.05$). The percentage of California respondents (59%) who believed, "Human-caused climate change has been established to be a serious problem and immediate action is necessary" was close to the total sample (57%).

Overall, prior awareness and experience—measured in the survey before valuation was assessed—of HEVs, PHEVs, BEVs, and FCEVs was so low that the reasonable assumption is most California new car buyers' prior assessments of these vehicles were based on ignorance. Awareness and experience were lower elsewhere. BEV name recognition was slightly higher in California than the other states: 35% of the CA sample provided a correct make-model name of a vehicle that is a BEV or comes in a BEV variant compared to 21% to 31% for the other states. However, despite the much greater variety of BEVs for sale in California than other states, the California sample was comparable to other states in the extent to which correct responses were limited to only two vehicles: in the California sample 95% of all correct BEV names were either Nissan Leaf or Tesla compared to 84% to 96% in the other states. Asked to rate their familiarity with HEVs, PHEVs, BEVs, and FCEVs, 15% (HEVs) to 39% (FCEVs) of respondents said they were unsure or decline to answer. Of those who did respond, the mean familiarity scores were low: compared to a mean score (on a scale from -3 to 3) of 2.37 for conventional ICEVs, mean familiarity scores ranged from 1.70 (HEVs) to -0.37 (FCEVs).

The percentage of the new car buyers in California who had heard the federal government “is offering incentives for consumers to buy vehicles that are powered by alternatives to gasoline and diesel” (49%) was statistically significantly higher ($\alpha < 0.05$) than for the total sample (44%). The percentage of respondents who had heard about incentives from all entities other than the federal government including states, cities, and electric utilities was far lower in California, as it was in all other participating states. The federal tax credit for PEVs was the only incentive uniformly available to PEV buyers anywhere in the US. The California sample was far more likely than any other state sample to say they had heard states in general offer incentives, and given they had heard states in general were offering incentives, the CA sample was much more likely to have heard “their state” was offering incentives (76% in CA; an average of 60% in the other participating states). However, for some states awareness should be low, as not all states offer incentives.

If respondents were “familiar enough with these types of vehicles to make a decision about whether one would be right for [their] household,” their familiarity was not gained from actual experience with PHEVs, BEVs, FCEVs, or even HEVs. Measured on a scale from -3 (none at all) to 3 (extensive driving experience) and excluding those who scored themselves as unsure or declined to answer, the *mean* scores for California respondents are all negative (HEVs, -1.14; BEVs, -1.97; PHEVs, -2.10; and FCEVs, -2.28) and the 75th quartile score for PHEVs, BEVs, and FCEVs varies from -1.77 (BEVs) to -2.73 (FCEVs). In short, within the realistic accuracy of the survey, more than three-fourths of this sample of CA new car buyers had *no* driving experience with PHEV, BEVs or FCEVs. This result held for the total sample, too.

Sightings of PEV charging infrastructure may be the most oft recognized sign of PEVs in those states that had programs to deploy workplace and/or public charging. On this measure, Californians were ahead of all the states in this study with the exception of Oregon: 66% of CA respondents claim to have seen a PEV charger in a parking garage or lot they use compared to OR (72%) and the total sample (52%).

ZEV Valuation: What vehicles do households design?

Respondents’ valuations of ZEVs were determined in the final design game in which no ZEVs were offered with both battery-powered all-electric drive and full-size body styles however there were incentives offered for PHEVs, BEVs, and FCEVs. The vehicle designs that were disallowed by the body size restriction are PHEVs that run solely on electricity until their batteries are depleted (at which point they switch to run as do present day HEVs and any other PHEV) and BEVs; PHEVs that run on both gasoline and electricity until the battery is depleted and FCEVs were allowed as full-size vehicles.

Ignoring for now differences between vehicles within each drivetrain type, e.g., ignoring differences in driving range across the BEV designs created by respondents, 38% of the CA respondents designed their next new vehicle to be a PHEV (21%), BEV (11%), or FCEV (6%). (As it is important for other policy goals, the single most common drivetrain design was HEV

(34%), far out-distancing the prevalence of HEVs in the both actual on-road fleet of vehicles and in new vehicle sales.)

PHEV Designs

- PHEV designs were likely to include longer range driving on electricity, but a charge depleting operating mode that uses gasoline too, i.e., "Assist" (such as the Prius Plug-in) rather than all-electric (such as the BMW i3 with range extender) charge depleting operation.
- Fast charging at home or at an (initially limited) network of quick chargers was not viewed as necessary by most who designed a PHEV; only 26% of those who designed a PHEV indicated they wanted the fastest charging offered at home; only 40% incorporated quick-charging capability (away-from-home).

BEV Designs

- BEV designs incorporated driving ranges from across the spectrum of offerings, i.e., 50 to 300 miles; just more than half (51%) designed BEVs with ranges of 125 miles or less.
    - The distribution of designs was bi-modal with peaks at 100 (22%) and 300 (28%) miles
- The distribution of home charging speeds was nearly uniform.
    - Two-thirds of those who designed a BEV believed they would be satisfied with a charging speed supplied by existing home 110V (36%) or 220V circuits (31%).
- Less than half (43.5%) incorporated quick charging capability.

FCEV Designs

- About half as many respondents designed FCEVs as BEVs.
- Range includes three possibilities: 150, 250, and 350 miles: over half opted for the longest.
- Home H_2 refueling was included in 45% of FCEV designs.
- There was no difference across driving range options in the likeliness respondents included home refueling.

The California sample was more likely to design their next new vehicle to be a PHEV, BEV, or FCEV than any other state sample with the exception of Oregon. These two states essentially tied in terms of the total percent of PHEVs, BEVs, plus FCEVs (CA, 38%; OR, 39%). The OR sample was a slightly more likely to design PHEVs than was the CA; the CA sample was more likely to design FCEVs than the OR sample. Of the study states and regions, the NESCAUM regional sample had the lowest percentage of PHEVs, BEVs, or FCEVs designs: 26%.

Who Designs Their Next New Vehicle to be a ZEV?

A nominal logistic regression model was estimated to test for the correlation of the concepts listed at the top of this section to the respondents' drivetrain types. The following were all associated with a higher likeliness of designing the household's next new vehicle to be a PEV or FCEV in the model for the California sample:

- Household vehicles, travel, and residences;
    - Higher home PEV charging access, i.e., higher level of electrical service, at the parking; location at the respondent's residence (PEV);
    - Natural gas available at the residence (FCEV);

- Attitudes related to policy goals: energy security, air quality, and global warming;
  - Stronger agreement that air pollution represents both a regional threat and a personal risk;
- Prior ZEV evaluation and experience as well as ZEV-specific attitudes;
  - Prior belief electricity is a likely replacement for gasoline and diesel;
  - Prior belief hydrogen is a likely replacement for gasoline and diesel;
  - Higher personal interest in ZEV technology;
  - Belief governments should offer incentives to consumers to buy vehicles powered by electricity and/or hydrogen, but especially one or the other;
  - Previously observed PEV charging in the (non-residence) parking facilities they use;
  - Higher familiarity with HEVs, PHEVs, BEVs, and FCEVs;
  - Higher familiarity with ICEVs;
  - Higher relative reliability and safety of BEVs compared to gasoline vehicles;
  - Better assessment of driving range and charging time of BEVs;
  - Better assessment of driving range and fueling time of FCEVs;
  - More experience driving PHEV, BEV, or FCEV;
  - More experience driving HEV;
  - Have already considered buying an BEV, including search for information, visited dealership for test drive, or own one already; and,
  - Have already considered buying an FCEV, including search for information, visited dealership for test drive, or own one already.

Similar models were estimated for Oregon, Washington, Maryland, Delaware, New Jersey, New York, Massachusetts, and the NESCAUM region. Comparing those models and California's the conceptual group of potential explanatory variables that provided the most separate measures to the greatest number of state and regional models of respondents' PEV and FCEV valuations was the one containing measures specific to PEVs, FCEVs, electricity, and hydrogen. These include:

- Belief that electricity or hydrogen are likely replacements for gasoline and diesel fuel;
- Personal interest in ZEV technology;
- Familiarity with all vehicle drivetrain types included in the design games: ICEVs, HEVs, PHEVs, EVs, and FCEVs;
- Prior assessments of EVs and FCEVs on six dimensions including charging/fueling, purchase price, safety, and reliability;
- Experience driving vehicles of the different drivetrain types;
- Whether respondents have already seen PEV charging in the parking facilities they use; and,
- Extent to which respondents have already considered acquiring a PEV or FCEV.

These comparisons provide broad support for the importance of the roles that higher levels of awareness, knowledge, experience, and prior consideration of PEVs and FCEVs have in explaining who is and is not presently interested in such vehicles for their household.

Why do people design ZEVs?

An alternative perspective on why respondents do or do not have sufficiently positive valuations of ZEVs to design one for their household comes from a set of post-design game questions in which respondents score a set of potential motivations (for designing a PHEV, BEV, or FCV if they do design one, for not designing one if they don't).

Highly rated motivations to design a ZEV were a mix of private and societal.

- Private: Savings on (fuel) costs, interest in new technology, safer than gasoline or diesel vehicles, convenient to charge at home, and fun to drive.
- Societal: Reducing personal contribution to climate change, oil imports, and air pollution as well as payments to oil producers.

For the California sample a cluster analysis indicates a four-cluster solution to the question of whether respondents share high (and low) rated motivations. "Pro-social technologists" scored all the pro-social issues (energy security, climate change, and air quality) well above average; they were also very highly motivated to save on "fuel costs." "Thrifty environmentalists" were first and foremost thrifty as they scored all cost motivations highly—including being the only cluster to indicate that incentives were important to their drivetrain design. They were environmentalists, second, as they rated climate change and air quality as above average motivations, but not nearly as highly as they scored the cost motivations. "Private hedonists" eschewed all social goals and motivations, describing their motives for designing a ZEV entirely in terms of the private performance attributes they imagined for these cars—fun to drive, comfortable, safe, good-looking cars that make the right impression on people and fit the respondent's lifestyle. The final cluster did not score any motive highly, and are left as a group about which we are left to ask why they designed a ZEV.

Comparing these results to a four-cluster solution for respondents from all other states revealed three of the four clusters appeared in both samples: "Pro-social technologists," "Private Hedonists," and the group showing no highly rated motivations. The fourth cluster for the all-other-states sample has a broader set of highly rated motivations than does the "Thrifty environmentalist" cluster in CA. This more generalist cluster for the other states had high average scores for some motivations in all the categories of ZEV technology, vehicle performance, costs, and ZEV policy goals.

Appeals to broader social goals may appeal to the "Pro-social technologists" and "Thrifty environmentalists." More conventional automotive marketing messages may appeal to the "Private hedonists." The cluster identified as "Why did they design a ZEV?" remains to be explained.

Why don't people design ZEVs?

- The highest scoring motivations against designing ZEVs had to do with their inherent newness: limited charging and fueling networks, high initial purchase price and limited range (as possible "1st generation technology"), unfamiliarity with such technology, including the effects on the electricity supply of deploying PEV technology, waiting for the technology to be proved reliable, and high operating and maintenance costs.
    - In addition to high initial purchase prices, maintenance and fueling costs were highly rated concerns.
    - Immediate, practical limits on the ability to charge a PEV at home as well as concerns about the overall reliability of electricity supply were highly rated motivations against PEVs.
    - Concerns about driving range of BEVs and FCEVs.

- Few acknowledged that greater incentives (of the kind offered in the game) would have changed their minds.

As with those who did design ZEVs, there appear to be distinct sets of motivations to ***not*** design one that are shared by clusters of respondents. The highest-level distinction in a three cluster solution for California was between two clusters who each had long lists of highly scored motivations vs. a third cluster who shared—just barely—the only two concerns all three clusters scored highly: high purchase price of ZEVs and the fact the respondents are unfamiliar with ZEV technology. The first two clusters were distinguished from each other in that one emphasized limited range, limited away-from-home charging/fueling networks, charging/fueling times, and purchase cost concerns while the other was the most highly concerned about their unfamiliarity with ZEV technology. The latter cluster's concern with limited fueling networks also extended to an inability to charge or fuel at home.

The motivations of those who don't design a PHEV, BEV, or FCEV were compared the California sample and all other states. Clusters of respondents with similar high- and low-scored motivations appear similar between the respondents from California and those from all other participating states. The comparison supports the broader conclusion that many new car buyers have many concerns and questions about PHEVs, BEVs, and FCEVs.

Unfamiliarity with ZEV technology was one of the motivations for not designing a PHEV, BEV, or FCEV that was widely shared. Misunderstandings about HEVs, PHEVs, and BEVs provided a partial explanation for why so many more people designed HEVs in the survey than buy them in the real world, but also provides encouragement that some consumers would more highly value PHEVs—especially those with all-electric charge-depleting operation—if they understood how the different vehicles operate. While experience might be the best teacher, the problem discussed here is people who aren't interested in accumulating the relevant experience in a PEV or FCEV. Images that make PEVs "normal" can help; the experiences of PEV drivers as related in on-line forums have been important sources of information—to those already inclined to seek them out.

POLICYMAKERS SUMMARY

The results presented in this report represent a population of new car-buying households who despite the increasing marketing of PEVs during the four years leading up to data collection, have not asked themselves the question, “Is a ZEV the right vehicle for my household”? As such, most respondents considered this question for the first time when they completed the on-line questionnaire. That these initial valuations are uncertain and unstable was demonstrated in the follow-up interviews with a small sub-set of respondents. In short, there remains both the opportunity and the need to provide consumers the impetus and means to answer the question.

The results of the modeling of respondents’ drivetrain designs and of the motivations they offer in response to their designs suggest avenues of policy design. That measures of whether respondents have already considered PEVs or FCEVs are correlated with their valuation of PEVs and FCEVs suggests the importance of initiating and shaping such considerations, but are vague as to how exactly to do so. More direction can be found in other variables in the model and other motivations.

The one ZEV policy goal that enters the model of the California respondents’ vehicle designs is air quality. A component that incorporates respondents’ assessments of both the regional threat of air pollution and their personal worry about it is associated with drivetrain type. Those more concerned about air pollution were more likely to design anything other than an ICEV. Whether or not it is good public policy to convince those Californians who are not worried about air pollution in their region to worry about it is a question for air quality regulators, air quality scientists, and public health professionals. Regardless, these attitudes towards air pollution suggest a public policy approach to marketing ZEVs.

Seven motivations were highly scored by more than one cluster of respondents who designed a PHEV, BEV, or FCEV: interest in ZEV technology, convenience of home charging, fuel cost savings, climate change, reducing payments to oil producers, and air quality. As just indicated for the case of air quality, each of these suggests messages and media for cross-cutting social networks to support market development—even “private hedonists” and “pro-social technologists” share the motivations of ZEV technology and fuel cost savings.

Pro-con: Two sides of similar coins?

Reviewing the top motivations for and against designing PEVs and FCEVs shows opposing positions regarding two ideas: new technology and costs. Many people with positive valuations of ZEVs, e.g., those who design a PHEV, BEV, or FCEV in the final design game, were interested in ZEV technology; many of those with negative valuations were worried about these new technologies. Many people with positive valuations saw electric drive vehicles as a way to take control of their spending on transportation fuel—both to save money and take control over to whom they pay their money. Many people with negative valuations saw PEVs and FCEVs as expensive to buy and possibly expensive to “fuel.” This view of motivations as two perspectives on the same things highlights possible ways to promote ZEVs to some people who are already favorably disposed while addressing concerns of some who are not.

Comparing high scoring to low scoring motivations across the pro- and con-ZEV groups furthers this thesis that confronted with an idea or attribute of ZEVs, identifiable groups of people have opposite responses. Environmental motivations were highly scored by many people with positive ZEV valuations. That ZEVs might have negative environmental outcomes was not highly rated as a motive to avoid ZEVs.

The distributions of motivations across almost all the respondents—including some in the smaller group who spent few points in the motivation exercise—suggests that attention to messages about ZEV technology can be broadly useful to promote ZEVs among those who are favorably disposed toward ZEVs and to overcome doubts and concerns among those who are not. Messages about air quality, energy security, and climate change will appeal to one-fifth of this sample of California new car buyers who highly score these motives. Almost as many respondents in California (617) were concerned about the effects of PEVs on electricity supply (as a subset of energy security issues) as belonged to both clusters with high pro-social motivations (630). In this sense, messages about energy security and electricity supply appeal to both a large group of people with positive ZEV valuations while addressing an important concern of many people with negative, or at least low, ZEV valuations.

Pro-con: Few are willing to say incentives are important

Financial incentives alone do not overcome the barriers and "dis-motivations" of the people who did not already have a favorable valuation of ZEVs. Less than 5% of those who did not design a ZEV strongly indicated that larger incentives would have changed their minds. Simply making the vehicles less expensive doesn't address their long lists of concerns and barriers, perceptual and real, to ZEV acquisition and use. Even for those who did design a PHEV, BEV, or FCEV, only 9% assigned the maximum value to the statement, "incentives made them too attractive to pass up." Nor did awareness of federal or California State incentives "for alternatives to gasoline and diesel" appear in the model of respondents' vehicle designs. The one sign of a positive effect of incentives comes from the difference between the first and third design games: 14% more people designed a ZEV in the third game than in the first. Keeping in mind that the vast majority of respondents in California choose the optional additional financial incentive (splitting four-to-three on whether that incentive was for the vehicle or home charging/fueling), the primary effect on the California respondents was for incentives to reduce the upfront costs of acquiring a ZEV.

Pro-con: Is there a schism in ZEV demand?

Within the set of respondents who designed a PHEV, BEV or FCEV in the final game there was some evidence of a pro-PEV/con-FCEV group and a con-PEV/pro-FCEV group. The existence of such a divide would be important because it appears to exist between people who claimed the highest level of prior consideration of PEVs and FCEVs and the highest level of interest in ZEV technology, that is, they had started to gather information, shopped for, or own a PEV and a FCEV.[40] The profiles of values of explanatory variables that maximize the probabilities of

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[40] It is improbable that any Californian presently has both a PEV and an FCEV, and therefore implausible that any are in the sample. The response category used in the model of drivetrain types groups together the three highest levels of consideration (own, shopped, and searched for information), thus, it is likely there are people who have

designing an PEV or an FCEV require that the measures of prior consideration of PEVs and FCEVs have opposite values: "I have gathered information, shopped for, or own a vehicle powered by electricity and I have not and would not consider a vehicle powered by hydrogen" vs. "I have gathered information, shopped for, or own a vehicle powered by hydrogen and I have not and would not consider a vehicle powered by electricity." Further, if the respondent believes only electricity *or* only hydrogen should be incentivized, then relatively minor changes to any other explanatory variables are required to produce a high probability of designing a vehicle with the favored drivetrain type.[41]

The Role of Government Incentives

While most of those who do not design a PHEV, BEV, or FCEV may be motivated by a long list of concerns, fewer seem outright resistant. When asked about whether they have already considered PEVs or FCEVs, only 15% of the CA sample replies they have not *and would not* consider buying an PEV, 25% an FCEV, and 12% neither one. If an actual opposition (at present) seems a small portion of new-car buyers, incentives play an unacknowledged role in positive valuations of ZEVs or may not address the first problems of those with negative valuations. We start by observing that prior to the introduction of incentives (modeled on those actually offered in the real world) in the vehicle design games in the survey, relatively few respondents were aware such incentives already exist in the real world: about half the sample claimed to have heard of federal incentives and about one third, California incentives. Offered financial purchase incentives and vehicle use incentives, respondents were far more likely to choose financial incentives.[42] Further, despite the dollar value being identical for both the vehicle purchase and home charging, among those who choose a direct financial incentive, respondents split about four-to-three as to which they want.

There appears to be an unwillingness (among those who do design a PHEV, BEV, or FCEV) to give credit to the introduction of incentives in the final design game despite the fact 14% more respondents designed a ZEV in the third game than in the first. Even among those who switched from an ICEV or HEV in the first game to a PHEV, BEV, or FCEV in the third do not rate incentives as an above average motivation. Most of those who committed to a PEV or FCEV design at any point in the survey did so without incentives. There are few among those unwilling to design a PEV or FCEV (4%) who indicate higher incentives would have changed their minds.

Nonetheless, incentives are an important part of the "saving money" motivations some give for ZEVs. Incentives are routinely reported to be instrumental to explain differences in PEV sales between states: high in those states and locales with high incentives, lower otherwise. Whether or

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searched for information about both types of vehicles and plausible that a few people in the sample own a PEV and have made inquiries about FCEVs.

[41] Changes from the profile of most frequent and mean values of the explanatory variables in Appendix Table B8.

[42] Anyone designing a qualifying PEV or FCEV was offered the equivalent of the existing federal tax credit and the choice of one other incentive. The other financial incentives were a vehicle purchase incentive (the value was taken from California's vehicle purchase rebate schedule at the time of the on-line survey) or an equivalent amount for a home EVSE or $7,500 for home H_2 refueling. Vehicle use incentives included single-occupant vehicle access to high occupancy vehicle lanes, reduced road and bridge tolls, or workplace charging.

not individual survey respondents are willing to say incentives are affecting their choices, incentives have become part of the discussion of ZEVs.

What are the obstacles to positive ZEV Valuation?

Even if a financial hurdle in the form of high purchase prices—which incentives can help push them over—is an important motivation for those who do not design a PHEV, BEV, or FCEV, what are the other problems?

1) Lack of awareness, knowledge, and consideration of PHEVs, BEVs, and FCEVs: the vast majority of respondents were constructing their valuation of these types of vehicles for the first time while completing the on-line survey deployed in this study. The results of this study indicate that despite the availability of PEVs for retail sale for four years (at the time the survey was conducted) in California, many new-car buyers—people who have been on new car lots shopping for and buying new cars—don't know ZEVs (specifically, PEVs) are for sale. Respondents are generally unable to name a BEV that is presently for sale. Among those California respondents who can name a BEV, 95% name one of two vehicles despite other makes and models being available. Additional support for the argument there is a general lack of awareness is found in answers to questions about driving experience: most of the sample has no driving experience with PHEVs, BEVs, or FCEVs. Further, asked directly whether they have already considered a PEV three-fourths of the California respondents indicate they have not, nine-tenths have not considered an FCEV.

2) Lack of knowledge and experience: the long list of motivations to not design a PHEV, BEV, or FCEVs, that is, the list of questions and concerns that most respondents have about ZEVs is itself a barrier. Many people simply have too many questions, certainly too many for financial purchase incentives alone to overcome. The misunderstandings and lack of understanding of PHEVs, BEVs, and FCEVs may be the most important finding of the interviews. Feedback during the follow-up interviews in California, Oregon, and Washington suggests the PHEV design concepts of charge-depleting and charge-sustaining operation as well as all-electric vs. assist modes caused considerable confusion. Much of the confusion crosses from HEVs to PHEVs to BEVs: interviewees spoke of choosing "assist" PHEV designs rather than "all-electric" PHEV designs because they were afraid of being stranded when the PHEVs battery was discharged. (At such a moment, the ICE in a PHEV would continue to power the vehicle.) We heard from people who (still) think that hybrid vehicles (HEVs) have to be plugged in.

Prompting the question, "Is a PHEV, BEV, or FCEV right for my household?" and addressing the concerns this question raises represent opportunities to build coalitions both on the supply side with vehicle, EVSE, and electricity providers and with communities of interest among potential consumers.

Building a market

How do we use these results to build markets for PEVs? One conceptual model is to view markets as built up from (sometimes overlapping) segments of consumers. Attitudes and beliefs regarding the environment and energy offer some ideas, as do motivations for—and against—a positive valuation of ZEVs.

The attachment of pro-social goals such as reduced threats from energy insecurity, climate change, and especially air pollution to ZEVs by the survey respondents points to interest groups around those issues who may be enlisted in a broader campaign to market the idea of ZEVs—as much or more than marketing any specific make and model of vehicle. (The latter being the purview of that vehicle's manufacturer.) Taking another tack, the constituency represented by the automotive enthusiast and consumer press was slow to see the consumer value of HEVs. In contrast to the early automotive press on HEVs, automotive reviews contemporaneous with the writing of this report indicate the potential for vehicles powered by electric motors to simply be the best available cars on many metrics including performance and other kinesthetic and aesthetic criteria.[43]

It seems clear from these results that the initial valuations people will form of ZEVs are still to be formed and are therefore subject to shaping through social marketing campaigns including education, outreach, and opportunities for direct experience driving ZEVs. The social marketing of ZEVs could be both broader and more focused: broader in the sense of appealing to all the reasons people have for forming positive valuations, more focused in the sense of crafting messages to appeal to positive motivations and address the concerns of those who do not have positive valuations. As an example of the latter, other work on consumers, PEVs, and green electricity indicates that explicitly co-marketing PEVs and green electricity builds market share for both. For those with positive valuations of PEVs built on energy security, climate change, or air quality, the package of a PEV plus green electricity ensures that the vehicle addresses their motivations. For those who lack a positive valuation of ZEVs because they question whether electricity is really cleaner than gasoline and are worried about the effect of many PEVs on electricity supply, tying PEVs to new sources of renewable electricity may address these concerns.

[43] http://www.npr.org/sections/thetwo-way/2015/08/27/435325951/new-tesla-breaks-consumer-reports-ratings-scale-bolsters-companys-stock

APPENDIX A: POTENTIAL EXPLANATORY VARIABLES

The table summarizes statistical associations between the dependent variable, i.e., the design of the drivetrain in the third design game, and several possible independent variables previewed in the previous section. In general, a threshold of α = 0.05 is used to establish statistical significance.

Table A1: Potential Explanatory Variables, Alternative Hypotheses, and Bivariate Result

Independent (Explanatory) Variable	Alternative Hypothesis (Rationale)	Bivariate Statistical Relationship to Dependent Variable: Drivetrain design
Number of vehicles	H_a: Households with more vehicles are more likely to design a PHEV, BEV, or FCEV than are households with fewer vehicles. (More experimentation with vehicle types, more body styles in household fleet to accommodate a variety of driving missions, spending more money on vehicles.)	H_o accepted: No significant relationship.
Number acquired as new since 2008	H_a: Households who have acquired more new vehicles since 2008 are more likely to design a PHEV, BEV, or FCEV. (More experimentation with vehicle types, more body styles in household fleet to accommodate a variety of driving missions, spending more money on vehicles.)	H_o accepted: No significant relationship.
Price paid for most recently acquired as new	H_a: Households who spent more are more likely to design a PHEV, BEV, or FCEV. (Spending more money on vehicles.)	H_o accepted: No significant relationship.
Respondent's vehicle's monthly miles	H_{a1}: Households who drive farther per month are more likely to design a PHEV, BEV, or FCEV. (Lower "fuel" prices of electricity may be attractive.) H_{a2}: Households who drive less per month are more likely to design a BEV or FCEV. (Existing travel may be more amenable to shorter range BEVs or FCEVs with a limited refueling network.)	H_o accepted: No significant relationship.
Respondent's car fuel spending per month	H_a: Households that spend more on fuel per month are more likely to design a PHEV or BEV. (Lower "fuel" prices of electricity may be attractive.)	H_o rejected: Respondents spending more on fuel for the car they drive most frequently are more likely to design BEVs or FCEVs.
Own fuel spending accuracy	H_a: Respondents that know their fuel spending more accurately will be more likely to design a PHEV, BEV or FCEV. (Lower "fuel" prices of electricity may be attractive.)	H_o rejected: Higher levels of self-reported accuracy of knowledge about fuel spending on fuel spending for the vehicle respondent drives most often is generally associated with a higher likeliness of designing an BEV, or FCEV.

Independent (Explanatory) Variable	**Alternative Hypothesis (Rationale)**	**Bivariate Statistical Relationship to Dependent Variable: Drivetrain design**
Own vehicle fuel economy	H_{a1}: Respondents driving vehicles with higher fuel economy will be more likely to design a PHEV or ZEV. (High fuel economy car represents commitment to energy security or climate change motives for PEVs and FCEVs.) H_{a2}: Respondents driving vehicles with higher fuel economy will be less likely to design a PHEV or BEV. (High fuel economy of present vehicle blunts fuel cost savings motive for PEVs.)	H_o rejected, partial support for H_{a1}: Respondents driving vehicles with higher fuel economy more likely to design BEVs.
Household total fuel cost	H_a: Households who spend more on fuel for their whole fleet of vehicles will be more likely to design a PHEV, BEV, or FCEV. (Lower "fuel" prices of electricity may be attractive.)	H_o accepted: No significant relationship.
Accuracy of total fuel cost	H_a: Households that know their fuel spending more accurately will be more likely to design a PHEV, BEV or FCEV. (Lower "fuel" prices of electricity may be attractive.)	H_o accepted: No significant relationship.
Replacement for gasoline and diesel: electricity	H_a: Households who are already inclined to believe that electricity is a likely replacement for gasoline and diesel will be more likely to design a PHEV or BEV. (Predisposition toward electricity; may have already spurred search for information.)	H_o rejected: If already inclined to believe electricity will replace gasoline and diesel, then more likely to design anything but ICEV.
Replacement for gasoline and diesel: hydrogen	H_a: Households who are already inclined to believe that hydrogen is a likely replacement for gasoline and diesel will be more likely to design a PHEV or BEV. (Predisposition toward hydrogen; may have already spurred search for information.)	H_o rejected: If already inclined to believe electricity will replace gasoline and diesel, then more likely to design anything but ICEV.
Replacement for gasoline and diesel: natural gas	H_a: Households who are already inclined to believe that hydrogen is a likely replacement for gasoline and diesel will be more likely to design a PHEV or BEV. (Predisposition toward hydrogen; may have already spurred search for information.)	H_o accepted: No significant relationship.
Daily flexibility (as to who drives which vehicle)	H_a: Households with more flexibility as to who drives and who drives which vehicle will be more likely to design an BEV. (Flexibility is a tool to adapt to short range.)	H_o rejected: Greater flexibility is associated with a higher likeliness to design a PHEV, BEV, or ZEV.
HOV lanes	H_a: Respondents who already drive on routes with HOV lanes may be particularly attracted by the incentive of single-driver HOV lane access, thus to design a PHEV, BEV, or PHEV. (Perceived time savings may be a	H_o rejected: Those who drive routes with HOV lanes are more likely to design PHEVs, BEVs, or FCEVs.

Independent (Explanatory) Variable	Alternative Hypothesis (Rationale)	Bivariate Statistical Relationship to Dependent Variable: Drivetrain design
	powerful incentive to design a qualifying vehicle.)	
Toll lanes	H_a: Respondents who already drive on routes with tools may be particularly attracted by the incentive of reduced tolls and thus to design a PHEV, BEV, or PHEV. (Perceived cost savings may be an incentive to design a qualifying vehicle.)	H_o rejected: Those who drive routes with toll lanes or facilities are more likely to design PHEVs, BEVs, or FCEVs.
Daily distance variation	H_a: Respondents with less variation in their daily travel will be more likely to design a BEV. (Greater variability may make it more difficult to imagine adapting to a limited range vehicle.)	H_o accepted: No significant relationship.
Commute to a workplace	H_a: Respondents who commute to work will be more likely to design a ZEV. (Greater regularity of travel and possibility of workplace charging may make it easier to adapt a PEV and ZEV. May also be income and/or age correlated.)	H_o rejected: Those who commute to a workplace in a household vehicle are more likely to design PHEV, BEVs, or FCEVs.
Park at least one vehicle in a garage or carport (at home)	H_a: Respondents who park at least one vehicle in a garage or carport (attached to their residence) are more likely to design a PHEV, BEV, or FCEV. (Certainty of parking location.)	H_o rejected: Those who park at least one vehicle in a garage or carport are more likely to design a PHEV or BEV, but not an FCEV.
Home PEV Charging Access	H_a: Respondents who more highly rate their access to charging (and to higher levels of electrical service) are more likely to design a PHEV or BEV. (Certainty of parking location and access to electricity.)	H_o rejected. Most of the effect is limited to those who design BEVs; access to the fastest charging is associated with higher likeliness to design a BEV.
Electricity installation authority	H_a: Respondents with the authority to make installations at their residence are more likely to design a PHEV or BEV. (Don't require permission from a property manager, landlord, or lender.)	H_o rejected: Those who could install higher power electrical service on their one authority are more likely to design PHEVs, BEVs, and FCEVs.
Home natural gas	H_a: Respondents with access to natural gas are more likely to design an FCEV. (Access to natural gas for hydrogen reforming for home hydrogen fueling.)	H_o provisionally rejected (α = 0.08). However, H_a is not supported—those with natural gas are less likely to design an FCEV.
Familiarity with gasoline vehicles	H_{a1}: Increasing familiarity with gasoline vehicles is associated with a *lower* likeliness to design an HEV, PHEV, BEV, or FCEV. (Familiarity with the present vehicle type produces conservatism toward alternatives.) H_{a2}: Increasing familiarity with gasoline vehicles is associated with a *higher* likeliness to design an HEV, PHEV, BEV, or FCEV. (Familiarity with the present vehicle type	H_o rejected: Increasing familiarity with gasoline vehicles associated with declining likeliness to design an FCEV and increasing likeliness to design an HEV or PHEV.

Independent (Explanatory) Variable	Alternative Hypothesis (Rationale)	Bivariate Statistical Relationship to Dependent Variable: Drivetrain design
	produces an attraction toward alternatives.)	
Familiarity with HEVs, BEVs, PHEVs, and FCEVs	H_{a1}: Increasing familiarity with each of these types of vehicles is associated with a *lower* likeliness to design one. (Familiarity with the alternative vehicle types produces conservatism toward them.) H_{a2}: Increasing familiarity with these types of vehicles is associated with a *higher* likeliness to design an HEV, PHEV, BEV, or FCEV. (Familiarity with the alternative vehicle type produces an attraction toward alternatives.)	H_0 rejected: H_{a2} generally supported. Higher familiarity associated with lower likeliness to design an ICEV.
Familiarity with ICEVs, HEVs, PHEVs, BEVs, and FCEVs: Two components solution. Components 1: HEVs, PHEVs, BEVs, and FCEVs Components 2: ICEVs	Alternative hypotheses are the same as for the familiarity measures for each individual measure of familiarity.	H_os rejected: Increasing score on Components 1 (increasing familiarity with PEVs, and FCEVs) associated with higher likeliness to design one. Increasing Components 2 associated with higher likeliness to design an HEV.
Environmental risk of electricity compared to gasoline	H_a: Respondents who believe electricity is a lower environmental risk than gasoline will be more likely to design a PHEV or BEV. (Desire to reduce environmental and health risks associated with their travel.)	H_o rejected. Lower comparative risk of electricity appears to be associated with lower likeliness to design an ICEV.
Human health risk of electricity compared to gasoline	H_a: Respondents who believe electricity is a lower human health risk than gasoline will be more likely to design a PHEV or BEV. (Desire to reduce environmental and health risks associated with their travel.)	H_o accepted: No significant relationship.
Seen public EVSEs	H_a: Respondents who have seen public chargers for PEVs will be more likely to design a PHEV or BEV. (Since EVSEs must have been seen "in lots and garages [they] use," seeing them may increase both the general perception that PEVs are real and provide a solution to a real or perceived barrier to using a PEV.)	H_o rejected: those who have seen public EVSEs are more likely to design a PEV or FCEV.
Driving experience: BEV Driving experience: HEV, PHEV, FCEV	H_a: Respondents who have higher levels of BEV driving experience will be more likely to design one. (Alternate measure of familiarity; higher familiarity leading to higher likeliness.) H_a: Same as for BEVs.	H_0 rejected. Higher BEV driving experience associated with higher likeliness to design BEV. In general, driving experience with HEVs, PHEVs, and FCEVs associated with higher likeliness to design a BEV.

Independent (Explanatory) Variable	Alternative Hypothesis (Rationale)	Bivariate Statistical Relationship to Dependent Variable: Drivetrain design
Driving experience: PHEV + BEV + FCEV	H_a: Similar to above, but an effort to see if combined experience across multiple vehicle types matters as much or more than experience with any one type.	H_o rejected: Higher combined experience driving PHEVs, BEVs, and FCEVs is associated with a lower likeliness of designing an ICEV and higher likeliness to design a BEV.
BEV home charging: “My household would be able to plug in a vehicle to charge at home.”	H_a: Stronger agreement associated with higher likeliness to design a PEV.	H_o rejected: Stronger agreement associated with lower likeliness to design an ICEV or HEV and increased likeliness of designing a ZEV.
BEV public charging: “There are enough places to charge electric vehicles.”	H_a: Stronger agreement associated with higher likeliness to design a PEV.	H_o rejected: Stronger agreement associated with lower likeliness to design an ICEV and higher likeliness to design a BEV.
BEV charge time: “It takes too long to charge electric vehicles.”	H_a: Stronger agreement associated with *lower* likeliness to design a PEV.	H_0 rejected: Higher agreement associated with higher probability of designing an ICEV.
BEV range: “Electric vehicles do not travel far enough before needing to be charged|.”	H_a: Stronger agreement associated with *lower* likeliness to design a PEV.	H_o rejected: Stronger agreement associated with higher likeliness to design an ICEV.
BEV purchase price: “Electric vehicles cost more to buy than gasoline vehicles.”	H_a: Stronger agreement associated with *lower* likeliness to design a PEV.	H_o rejected: Stronger agreement associated with higher likeliness to design an ICEV.
BEV safety: “Gasoline powered cars are safer than electric vehicles.”	H_a: Stronger agreement associated with *lower* likeliness to design a PEV.	H_o rejected: Stronger agreement associated with higher likeliness to design an ICEV.
BEV reliability: “Gasoline powered cars are more reliable than electric vehicles.”	H_a: Stronger agreement associated with *lower* likeliness to design a PEV.	H_o rejected: Stronger agreement associated with higher likeliness to design an ICEV.
Overall BEV Impression: Sum (with proper attention to the valence of the original statement) of the seven variables just describing respondent’s impression of BEVs.	H_a: Attempt to measure the effect of an overall evaluation of PEVs; higher score will be associated with higher likeliness to design a PEV. Positive scores = positive impression. Simple summing treats all dimensions as equally valuable.	H_o rejected: Higher scores, i.e., more pro-BEV evaluation of BEVs, are associated with lower likeliness to design an ICEV and a higher likeliness of designing a BEV.
Four components solution to a principal components of the seven dimensions of prior BEV evaluation	H_a: Attempt to measure the effect of an overall evaluation of PEVs, the principal components searches for a smaller number of components that summarizes the seven dimensions of PEV evaluation.	Four components correlated to drivetrain design: 1) Safety-Reliability, 2) Driving Range-Charging Time, 3) Home and Away-from-home Charging, and 4) Purchase Price.

Independent (Explanatory) Variable	Alternative Hypothesis (Rationale)	Bivariate Statistical Relationship to Dependent Variable: Drivetrain design
FCEV public refueling: “There are enough places for drivers to refuel their cars and trucks with hydrogen.”	H_a: Stronger agreement associated with higher likeliness to design an FCEV.	H_0 rejected: Stronger agreement there are enough places to refuel FCEVs associated with higher likeliness to design an FCEV.
FCEV fueling time: “Hydrogen fuel cell vehicles take too long to refuel.”	H_a: Stronger agreement associated with *lower* likeliness to design an FCEV.	H_o rejected: Stronger agreement associated with higher likeliness to design BEV.
FCEV range: “Hydrogen fuel cell vehicles do not travel far enough without needing to be refueled.”	H_a: Stronger agreement associated with *lower* likeliness to design an FCEV.	H_o rejected: Stronger agreement associated with lower likelihood to design FCEV.
FCEV purchase price: “Hydrogen fuel cell vehicles cost more than gasoline cars.	H_a: Stronger agreement associated with *lower* likeliness to design an FCEV.	H_o rejected: Stronger agreement associated with lower likelihood to design FCEV.
FCEV safety: “Gasoline vehicles are safer than hydrogen fuel cell vehicles.”	H_a: Stronger agreement associated with *lower* likeliness to design an FCEV.	H_o rejected: Decreasing confidence in the relative safety of hydrogen compared to gasoline is associated with a higher likeliness to design an ICEV.
FCEV reliability: Gasoline vehicles are more reliable than hydrogen fuel cell vehicles.”	H_a: Stronger agreement associated with *lower* likeliness to design an FCEV.	H_o rejected: Decreasing confidence in the relative safety of hydrogen compared to gasoline is associated with a higher likeliness to design an ICEV.
Overall FCEV Impression: Sum of the six variables describing respondent’s impression of BEVs.	H_a: Attempt to measure the effect of an overall evaluation of FCEVs; higher score will be associated with higher likeliness to design an FCEV. Positive scores = positive impression. Simple summing treats all dimensions as equally valuable.	H_o rejected: Better overall prior evaluation of FCEVs associated with higher likeliness to design FCEVs.
Three components solution to the principal components of the six dimensions of FCEV evaluation. (Note the measure for Purchase Price does not load on any of the three components.)	H_a: Attempt to measure the effect of an overall evaluation of FCEVs, the principal components searches for a smaller number of components that summarizes the seven dimensions of PEV evaluation.	H_o rejected: Components 1 (safety-reliability) associated with a higher likeliness to design an ICEV. (High scores on the components indicate gasoline is safer or more reliable.) Components 2 (Driving range-fueling time) higher scores (worse evaluation of FCEV) associated with lower likeliness to design FCEV. Components 3 (public fueling) associated with a higher likeliness to design a BEV or FCEV.
Incentives to consumers to buy and drive vehicles	For each entity, H_a: Those already aware of incentives will be more likely to design a	

Independent (Explanatory) Variable	**Alternative Hypothesis (Rationale)**	**Bivariate Statistical Relationship to Dependent Variable: Drivetrain design**
powered by alternatives to gasoline and diesel:	qualifying vehicle.	
Federal government.		H_o rejected: Prior belief that federal government offers incentives associated with higher likeliness of designing a PEV or FCEV.
State government		H_o rejected: Prior beliefs that state governments offer incentives associated with higher likeliness of designing a PEV or FCEV.
My state government (California)		H_o accepted: No significant effect.
Should governments offer incentives	H_a: Those who believe governments should offer incentives will be more likely to design a PHEV, BEV, or FCEV. (To the extent ZEVs have been politicized, responses may be shaped by people's ideas about the "proper" role of government.)	H_0 rejected. Those who are opposed to or unsure governments offering incentives are more likely to design ICEVs.
Prior consideration of BEVs	H_{a1}: Higher levels of consideration of BEVs prior to completing the survey will be associated with *higher* likeliness of designing a BEV. (BEVs are making a *favorable* impression on more consumers than not.) H_{a2}: Higher levels of consideration of BEVs prior to completing the survey will be associated with *lower* likeliness of designing a BEV. (BEVs are making a *unfavorable* impression on more consumers than not.)	H_0 rejected: H_{a1} supported. Those who have given greater prior consideration to buying a BEV are more likely to design a PHEV, BEV, or FCEV.
Prior consideration of FCEVs	H_{a1}: Higher levels of consideration of FCEVs prior to completing the survey will be associated with *higher* likeliness of designing an FCEV. (FCEVs are making a *favorable* impression on more consumers than not.) H_{a2}: Higher levels of consideration of FCEVs prior to completing the survey will be associated with *lower* likeliness of designing FCEVs. (FCEVs are making a *unfavorable* impression on more consumers than not.)	H_{a1} supported, but statistical tests are suspect because of small sample size. Those who have given greater prior consideration to buying a BEV are more likely to design a PHEV, BEV, or FCEV.
Urgent national need to displace gasoline and diesel	H_a: Stronger agreement there is an urgent national need for alternatives will be associated with a higher likeliness to design a PHEV, BEV, or FCEV.	H_0 rejected. Stronger agreement associated with lower likeliness to design an ICEV or HEV.

Independent (Explanatory) Variable	Alternative Hypothesis (Rationale)	Bivariate Statistical Relationship to Dependent Variable: Drivetrain design
Market will produce all required incentives	H_a: Those who believe free markets would produce all necessary incentives will be less likely to design a PHEV, BEV, or FCEV. (To the extent ZEVs have been politicized, responses may be shaped by people's ideas about the "proper" role of government.)	H_o accepted: no significant relationship.
Air pollution and individual lifestyle	H_a: Stronger agreement that individual lifestyle change affects air pollution will be associated with a higher likeliness to design a PHEV, BEV, or FCEV.	H_o rejected: Stronger agreement that air quality is affected by individual lifestyle is associated with lower likeliness to design and ICEV.
Personal worry about air quality	H_a: Stronger agreement that the respondent personally worries about air quality will be associated with a higher likeliness to design a PHEV, BEV, or FCEV.	H_o rejected: Stronger agreement that air quality is a personal worry is associated with lower likeliness to design and ICEV.
Air pollution a regional health threat	H_a: Stronger agreement that air pollution is a threat in the respondent's region will be associated with a higher likeliness to design a PHEV, BEV, or FCEV.	H_o rejected: Stronger agreement that air quality is a regional threat is associated with lower likeliness to design and ICEV.
Certainty there is, or is not, evidence for rising global average temperatures.	H_a: Stronger agreement there is solid evidence of global warming will be associated with a higher likeliness to design a PHEV, BEV, or FCEV.	H_o rejected: Greater certainty there is solid evidence of global warming is associated with lower likeliness to design an ICEV and greater likeliness to design a PHEV.
Warming human-caused or natural NOTE: This question is only asked of the people who believe there is evidence for global warming.	H_a: Stronger agreement global warming is human-caused will be associated with a higher likeliness to design a PHEV, BEV, or FCEV.	H_o rejected: Stronger agreement that global warming is human-caused is associated with lower likeliness to design an ICEV and greater likeliness to design a BEV.
Climate change and individual lifestyle	H_a: Stronger agreement that individual lifestyle change affects climate will be associated with a higher likeliness to design a PHEV, BEV, or FCEV.	H_o rejected: Stronger agreement that global warming is human-caused is associated with lower likeliness to design an ICEV.
Four Components Solution to Societal Motivations: Energy security, air quality, global warming	H_a: Stronger pro-societal believes will be associated with higher likeliness to design a PEV or FCEV.	
	Components 1: Air pollution is a regional threat and personal worry	H_o rejected: Higher concern linked to lower likeliness to design ICEV or HEV.
	Components 2: Environmental and health risk of electricity compared to gasoline	H_o accepted: No significant relationship.
	Components 3: Climate change is subject to individual lifestyle decisions	H_o rejected: Higher belief linked to lower likeliness to design

Independent (Explanatory) Variable	Alternative Hypothesis (Rationale)	Bivariate Statistical Relationship to Dependent Variable: Drivetrain design
	Components 4: Urgent National Need to transition from gasoline and diesel fuel	ICEV. H_o rejected: Higher concern linked to lower likeliness to design ICEV or HEV.
Own or rent residence	H_a: Respondents who own their residence will be more likely to design a PHEV, BEV, or FCEV.	H_o rejected: Owners more likely to design PEVs and FCEVs.
Residence type	H_a: Residents of single family dwellings will be more likely to design a PHEV, BEV, or FCEV.	H_o accepted: No significant relationship.
Solar panels on residence	H_a: Respondents who already have solar panels installed on their residence will be more likely to design a PHEV, BEV, or FCEV.	H_o rejected: Those with solar are more likely to design PEVs and FCEVs.
Household size	H_a: No specific alternative hypotheses.	H_o accepted: No significant effect.
Respondent age	H_a: Respondents age 40 to 59 will be more likely to design a PHEV, BEV, or FCEV. (Matches profile of the majority of early PEV buyers/lessors.)	H_o rejected, but H_a not supported: Younger people more likely to design PEVs and FCEVs.
Respondent gender	H_a: Male respondents will be more likely to design a PHEV, BEV, or FCEV. (Matches profile of the majority of early PEV buyers/lessors.)	H_o rejected, H_a supported: Men are more likely to design PEVs and FCEVs; women, HEVs.
Respondent employment status	H_a: Employed persons more likely to design ZEVs because of age, income, and commute.	H_o rejected; H_a supported.
Retired person in home	H_a: Proxy for age.	H_o rejected: Households with a retired person are more likely to design ICEVs and HEVs.
Children in household	No specific alternative hypothesis.	H_o accepted: No significant effects.
Technophile in the household	H_a: Households with a technophile will be more likely to design a PHEV, BEV, or FCEV. (Matches profile of the majority of early PEV buyers/lessors.)	H_o rejected: Greater likeliness of a technophile in the home is associated with a higher likeliness to design a PEV or FCEV.
Respondent's own interest in ZEV technology	H_a: Respondents who are personally interested in ZEV technology will be more likely to design a PHEV, BEV, or FCEV. (Matches profile of the majority of early PEV buyers/lessors.)	H_o rejected: Greater interest in ZEV technology is associated with higher likeliness to design a PHEV, BEV, or FCEV.
Respondent's education	H_a: Respondents with higher education will be more likely to design a PHEV, BEV, or FCEV. (Matches profile of the majority of early PEV buyers/lessors.)	H_o rejected, but effect is mixed. Generally a declining likeliness to design an ICEV with increasing education.
Political party affiliation	H_a: Lefties more likely to design a PHEV,	H_o rejected: Democrats more

Independent (Explanatory) Variable	**Alternative Hypothesis (Rationale)**	**Bivariate Statistical Relationship to Dependent Variable: Drivetrain design**
	BEV, or FCEV. (Presently, federal initiatives are the product of a Democratic administration.)	likely to design HEVs, PEVs, and FCEVs; Republicans more likely to design ICEVs; effect mixed among those who declare "None" or "Other" political affiliation.
Household income	H_a: Higher income households will be more likely to design a PHEV, BEV, or FCEV. (Matches profile of the majority of early PEV buyers/lessors.)	H_o accepted: No significant relationship.
History leasing vehicles	H_a: Households with a history of leasing will be more likely to design a PHEV, BEV, or FCEV. (Matches profile of the majority of early PEV buyers/lessors.)	H_o accepted: No significant effects.

APPENDIX B: NOMINAL LOGISTIC REGRESSION MODEL OF DRIVETRAIN TYPES IN FINAL DESIGN GAME, CALIFORNIA

Nominal logistic regression is used because the variable to be explained consists of a small number of distinct possibilities that don't define a particular order—ICEV, HEV, PHEV, BEV, or FCEV—rather than a continuous, ordered scale. The starting set of explanatory variables was the set of socio-economic and demographic variables because a distinct socio-economic, demographic profile distinguishes the population of people who have already acquired PEVs. As generalizations, those people have higher incomes and more years of formal education and are more likely to be male and homeowners than are the population of all California households and all California households that buy new vehicles. From this starting point additional candidate explanatory variables (or the components that represent them) are entered into the model. As each variable is entered its affect on the model is evaluated. Does the new variable improve the model fit? Does the variable itself surpass the threshold of statistical significance to be included? Does its presence cause other variables in the model to fall below the threshold level for inclusion? Variables not meeting the threshold for inclusion are removed one at a time. When no more variables can be removed by this rule, the process of testing additional new variables resumes. When all the variables have been tested, then the variables included in the model are removed one at a time to test for the effect on the overall model. If the model is statistically worse, the variable is returned and another removed. This process ceases when it is confirmed no variable can be removed without significantly degrading the model.

The whole model test (Table B1) evaluates whether all explanatory variables together provide a better fit to the data than fitting the overall probability of each drivetrain type. In this case, the tiny probability (<0.0001) of obtaining a larger chi-square by chance indicates the explanatory variables, taken together, provide a better fit. The measures of how well the model performs (Table B2) are typical for nominal logistic regression. The lack of fit test (Table B3) evaluates whether more complex terms such as interactions between the variables would add to the explanatory power of the model. The statistical tests reject this idea. The effect tests in Table B4 simply confirm that all the explanatory variables are statistically significant.

Table B1: Whole Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	376.2320	112	752.4639	<0.0001
Full	2053.3408			
Reduced	2429.5728			

Table B2: Goodness of fit measures

Measure	Training	Definition
Entropy RSquare	0.155	1-Loglike(model)/Loglike(0)
Generalized RSquare	0.384	(1-(L(0)/L(model))^(2/n))/(1-L(0)^(2/n))
Misclassification Rate	0.5267	∑ (ρ[j]≠ρMax)/n

Measure	Training Definition
N	1668

Table B3: Lack Of Fit

Source	DF	-LogLikelihood	ChiSquare
Lack Of Fit	6544	2053.3408	4106.682
Saturated	6656	0.0000	**Prob>ChiSq**
Fitted	112	2053.3408	1.0000

Table B4: Effect Likelihood Ratio Tests

Source	Number of parameters	DF	L-R ChiSquare	Prob>ChiSq
Replacement: Electricity	4	4	31.3576	<0.0001
Replacement: Hydrogen	4	4	10.3927	0.0343
Highest Home PEV Charging Access	12	12	32.6472	0.0011
Home natural gas	4	4	9.4773	0.0502
Familiarity Components1: HEVs, PEVs, FCEVs	4	4	12.9660	0.0114
Familiarity Components2: ICEVs	4	4	16.6656	0.0022
Driving Experience Components1: PEV, FCEV	4	4	15.2218	0.0043
Driving Experience Components2: HEV	4	4	18.7583	0.0009
Prior BEV Components1: Safety-reliability	4	4	11.6598	0.0201
Prior BEV Components2: Driving range-Charging time	4	4	13.5383	0.0089
Prior FCEV Components2: Safety-reliability	4	4	12.2304	0.0157
Prior Consider BEV	12	12	51.2435	<0.0001
Prior Consider FCEV	12	12	26.9665	0.0078
Should government offer incentives	16	16	30.6958	0.0147
Seen Public EVSEs yes/no	4	4	9.6981	0.0458
Personal interest in ZEV tech	12	12	41.4652	<0.0001
Environment Components1b: Air quality regional threat and personal risk	4	4	22.5461	0.0002

The parameter estimates in Table B5 provide the details of how and to what extent the explanatory variables affect the relative odds that a respondent with any particular set of responses would design one type of drivetrain rather than another. The statistical algorithm sets aside one of the possible answers and calculates the odds of all other answers compared to that one. In this case, FCEVs are the excluded category. So, strictly speaking the parameter estimates address the question of how likely it is a respondent designs any other drivetrain type in comparison to the odds they design an FCEV. The model parameters are interpreted in the text.

Table B5: Parameter Estimates

Term	Parameter Estimate	Standard Error	Chi-Square	Probability >ChiSquare
Intercept (Gasoline)	1.300	0.288	20.40	**<0.0001**
Replacement: Electricity[No]	0.384	0.145	7.01	**0.008**
Replacement: Hydrogen[No]	0.501	0.154	10.54	**0.001**
Highest Home PEV Charging Access[No]	0.189	0.270	0.49	0.484
Highest Home PEV Charging Access[110V]	0.170	0.209	0.66	0.416
Highest Home PEV Charging Access[220V]	-0.416	0.227	3.37	**0.067**
Home natural gas[No, we don't have natural gas]	-0.034	0.145	0.06	0.813
Familiarity Components1	0.041	0.179	0.05	0.818
Familiarity Components2	0.194	0.197	0.96	0.326
Driving Experience Components1	-0.604	0.179	11.36	**0.001**
Driving Experience Components2	-0.326	0.200	2.67	0.103
Prior BEV Components1	0.524	0.190	7.62	**0.006**
Prior BEV Components2	0.267	0.161	2.75	**0.097**
Prior FCEV Components2	0.287	0.229	1.57	0.210
Prior Consider BEV [Gathered info to shopped to own]	-0.153	0.266	0.33	0.565
Prior Consider BEV [The idea has occurred, but no real steps have been taken to shop for one]	-0.388	0.219	3.14	**0.077**
Prior Consider BEV[I (we) have not considered buying a vehicle that runs on electricity but maybe someday we will]	0.236	0.262	0.81	0.369
Prior Consider FCEV[Gathered info to shopped to own]	-1.055	0.330	10.20	**0.001**
Prior Consider FCEV[The idea has occurred, but no real steps have been taken to shop for one]	-0.120	0.239	0.25	0.616
Prior Consider FCEV[I (we) have not considered buying a vehicle that runs on hydrogen but maybe someday we will]	0.194	0.231	0.71	0.401
Should government offer incentives[I'm not sure]	0.804	0.426	3.57	**0.059**
Should government offer incentives[No, neither one]	0.728	0.429	2.88	**0.090**

Term	Parameter Estimate	Standard Error	Chi-Square	Probability >ChiSquare
Should government offer incentives[Yes, but only electricity]	-0.259	0.335	0.60	0.441
Should government offer incentives[Yes, but only hydrogen]	-1.534	0.505	9.24	**0.002**
Seen Public EVSEs yes/no[No]	0.131	0.151	0.75	0.386
Personal interest in ZEV tech[Not interested]	0.559	0.479	1.36	0.243
Personal interest in ZEV tech[A little interested]	0.010	0.271	0.00	0.972
Personal interest in ZEV tech[Interested]	0.026	0.257	0.01	0.918
Environment Components1b	-0.605	0.191	10.04	**0.002**
Intercept (HEV)	1.759	0.264	44.30	**<0.0001**
Replacement: Electricity[No]	0.006	0.140	0.00	0.965
Replacement: Hydrogen[No]	0.355	0.138	6.56	**0.010**
Highest Home PEV Charging Access[No]	0.399	0.257	2.41	0.120
Highest Home PEV Charging Access[110V]	0.116	0.196	0.35	0.553
Highest Home PEV Charging Access[220V]	-0.485	0.209	5.37	**0.021**
Home natural gas[No, we don't have natural gas]	-0.242	0.139	3.02	**0.082**
Familiarity Components1	-0.008	0.173	0.00	0.964
Familiarity Components2	0.557	0.190	8.61	**0.003**
Driving Experience Components1	-0.539	0.164	10.77	**0.001**
Driving Experience Components2	-0.014	0.184	0.01	0.940
Prior BEV Components1	0.322	0.179	3.23	**0.072**
Prior BEV Components2	0.219	0.151	2.12	0.145
Prior FCEV Components2	0.531	0.215	6.11	**0.013**
Prior Consider BEV[Gathered info to shopped to own]	-0.043	0.247	0.03	0.861
Prior Consider BEV[The idea has occurred, but no real steps have been taken to shop for one]	0.004	0.207	0.00	0.984
Prior Consider BEV[I (we) have not considered buying a vehicle that runs on electricity but maybe someday we will]	0.294	0.256	1.33	0.250
Prior Consider FCEV[Gathered info to shopped to own]	-0.526	0.278	3.58	**0.059**
Prior Consider FCEV[The idea has occurred, but no real steps have been taken to shop for one]	-0.328	0.218	2.26	0.133
Prior Consider FCEV[I (we) have not considered buying a vehicle that runs on hydrogen but maybe someday we will]	0.082	0.215	0.15	0.702
Should government offer incentives[I'm not sure]	0.372	0.414	0.81	0.369

Term	Parameter Estimate	Standard Error	Chi-Square	Probability >ChiSquare
Should government offer incentives[No, neither one]	0.267	0.420	0.40	0.525
Should government offer incentives[Yes, but only electricity]	-0.251	0.308	0.66	0.415
Should government offer incentives[Yes, but only hydrogen]	-0.515	0.376	1.88	0.171
Seen Public EVSEs yes/no[No]	-0.038	0.146	0.07	0.795
Personal interest in ZEV tech[Not interested]	0.176	0.478	0.14	0.713
Personal interest in ZEV tech[A little interested]	0.194	0.265	0.54	0.464
Personal interest in ZEV tech[Interested]	0.320	0.247	1.68	0.195
Environment Components1b	-0.248	0.187	1.76	0.185
Intercept (PHEV)	1.073	0.278	14.94	**0.0001**
Replacement: Electricity[No]	-0.035	0.145	0.06	0.811
Replacement: Hydrogen[No]	0.336	0.141	5.64	**0.018**
Highest Home PEV Charging Access[No]	-0.226	0.271	0.69	0.405
Highest Home PEV Charging Access[110V]	0.236	0.200	1.39	0.238
Highest Home PEV Charging Access[220V]	-0.242	0.212	1.30	0.254
Home natural gas[No, we don't have natural gas]	-0.057	0.142	0.16	0.687
Familiarity Components1	0.024	0.180	0.02	0.893
Familiarity Components2	0.505	0.195	6.70	**0.010**
Driving Experience Components1	-0.551	0.167	10.90	**0.001**
Driving Experience Components2	0.185	0.185	1.00	0.318
Prior BEV Components1	0.188	0.183	1.06	0.303
Prior BEV Components2	0.060	0.152	0.15	0.695
Prior FCEV Components2	0.619	0.219	7.97	**0.005**
Prior Consider BEV[Gathered info to shopped to own]	0.298	0.252	1.40	0.237
Prior Consider BEV[The idea has occurred, but no real steps have been taken to shop for one]	0.082	0.215	0.15	0.703
Prior Consider BEV[I (we) have not considered buying a vehicle that runs on electricity but maybe someday we will]	-0.037	0.267	0.02	0.891
Prior Consider FCEV[Gathered info to shopped to own]	-0.569	0.283	4.05	**0.044**
Prior Consider FCEV[The idea has occurred, but no real steps have been taken to shop for one]	-0.438	0.224	3.82	**0.051**
Prior Consider FCEV[I (we) have not considered buying a vehicle that runs on hydrogen but maybe someday we will]	0.256	0.220	1.36	0.244

Term	Parameter Estimate	Standard Error	Chi-Square	Probability >ChiSquare
Should government offer incentives[I'm not sure]	0.483	0.427	1.28	0.259
Should government offer incentives[No, neither one]	0.308	0.435	0.50	0.480
Should government offer incentives[Yes, but only electricity]	-0.385	0.320	1.45	0.229
Should government offer incentives[Yes, but only hydrogen]	-0.655	0.399	2.69	0.101
Seen Public EVSEs yes/no[No]	-0.095	0.152	0.39	0.533
Personal interest in ZEV tech[Not interested]	-0.354	0.508	0.49	0.486
Personal interest in ZEV tech[A little interested]	-0.017	0.277	0.00	0.952
Personal interest in ZEV tech[Interested]	0.539	0.256	4.44	**0.035**
Environment Components1b	-0.272	0.192	2.01	0.156
Intercept (BEV)	0.352	0.311	1.28	0.258
Replacement: Electricity[No]	0.036	0.159	0.05	0.822
Replacement: Hydrogen[No]	0.298	0.158	3.59	**0.058**
Highest Home PEV Charging Access[No]	-0.118	0.297	0.16	0.691
Highest Home PEV Charging Access[110V]	-0.087	0.218	0.16	0.692
Highest Home PEV Charging Access[220V]	-0.034	0.226	0.02	0.881
Home natural gas[No, we don't have natural gas]	-0.037	0.155	0.06	0.810
Familiarity Components1	0.492	0.209	5.52	**0.019**
Familiarity Components2	0.454	0.219	4.30	**0.038**
Driving Experience Components1	-0.326	0.177	3.40	**0.065**
Driving Experience Components2	0.196	0.199	0.97	0.325
Prior BEV Components1	0.186	0.199	0.87	0.351
Prior BEV Components2	-0.138	0.163	0.71	0.398
Prior FCEV Components2	0.650	0.240	7.31	**0.007**
Prior Consider BEV[Gathered info to shopped to own]	0.741	0.271	7.50	**0.006**
Prior Consider BEV[The idea has occurred, but no real steps have been taken to shop for one]	0.026	0.237	0.01	0.913
Prior Consider BEV[I (we) have not considered buying a vehicle that runs on electricity but maybe someday we will]	-0.177	0.296	0.36	0.549
Prior Consider FCEV[Gathered info to shopped to own]	-0.441	0.300	2.16	0.142
Prior Consider FCEV[The idea has occurred, but no real steps have been taken to shop for one]	-0.732	0.249	8.61	**0.003**
Prior Consider FCEV[I (we) have not	0.097	0.239	0.16	0.686

Term	Parameter Estimate	Standard Error	Chi-Square	Probability >ChiSquare
considered buying a vehicle that runs on hydrogen but maybe someday we will]				
Should government offer incentives[I'm not sure]	0.539	0.463	1.36	0.244
Should government offer incentives[No, neither one]	0.323	0.482	0.45	0.503
Should government offer incentives[Yes, but only electricity]	0.293	0.332	0.78	0.378
Should government offer incentives[Yes, but only hydrogen]	-1.214	0.502	5.84	**0.016**
Seen Public EVSEs yes/no[No]	-0.156	0.171	0.84	0.360
Personal interest in ZEV tech[Not interested]	-0.063	0.545	0.01	0.907
Personal interest in ZEV tech[A little interested]	0.043	0.302	0.02	0.888
Personal interest in ZEV tech[Interested]	0.426	0.276	2.39	0.122
Environment Components1b	-0.270	0.207	1.70	0.192

Overall model performance

A summary view of how well the model performs is provided in Table B6 where the actual drivetrain designs (created by each of the 1,668 respondents used to estimate the model) are cross-classified by the drivetrains “predicted” for them by the model. Comparing the column totals (predicted designs) to the row totals (actual game totals), the model overestimates the number of HEVs (772 predicted compared to 574 observed) and underestimates PHEVs, BEVs, or FCEVs. For example, of 358 respondents who designed a PHEV), the model correctly assigns a PHEV design to fewer than half (114) and underestimates (274) the total number of PHEV designs. The model does a poor job distinguishing who designs a BEV or an FCEV.

Table B6: CA Actual and predicted drivetrain designs, Game 3

	Predicted Design					
	ICEV	**HEV**	**PHEV**	**BEV**	**FCEV**	**Actual Game Total**
Actual Game 3 Design						
ICEV	271	152	24	9	3	459
HEV	123	346	73	27	5	574
PHEV	48	163	114	25	8	358
BEV	15	77	41	44	7	184
FCEV	13	34	22	9	15	93
Predicted Total	470	772	274	114	38	1,668

Table B7: Values of explanatory variables for baseline estimation of the probability distribution of Game 3 drivetrain designs, sorted by the importance of the total effect of each explanatory variable

		Variable Importance	
Explanatory Variable	**Value in Baseline Estimate**	**Main Effect**	**Total Effect**
Replacement: Electricity	No	0.095	0.095
Replacement: Hydrogen	No	0.095	0.095
Highest Home PEV Charging Access	None	0.095	0.095
Home natural gas	No	0.095	0.095
Prior Consideration of an BEV	Gathered info/shopped/own	0.095	0.095
Prior Consideration of an FCEV	Gathered info/shopped/own	0.095	0.095
Should government offer incentives	I'm not sure	0.095	0.095
Seen Public EVSEs	No	0.095	0.095
Personal interest in ZEV technology	Not interested	0.095	0.095
Environment Components1b (Regional and personal AQ)	~0	0.031	0.070
Driving Experience Components2 (HEVs)	~0	0.022	0.034
Familiarity Components2 (ICEVs)	~0	0.010	0.029
Prior BEV Components1 (safety-reliability)	~0	0.021	0.024
Familiarity Components1 (HEVs, PHEVs, BEVs, FCEVs)	~0	0.022	0.022
Driving Experience Components1 (PHEVs, BEVs, FCEVs)	~0	0.019	0.019
Prior BEV Components2 (driving range-charging time)	~0	0.014	0.014
Prior FCEV Components2 (driving range-fueling time)	~0	0.007	0.007

Example Profiles of Values of Explanatory Variables

Table B8 summarizes the values of the explanatory variables used for a baseline estimation of the likeliness of respondents' drivetrain designs. The estimation algorithm selects values for each explanatory variable to produce a baseline estimate. For example, for explanatory variables that have only a few discrete possible values, the value used for baseline estimates are the minimum values (if the values are ordered) or the first value in a list of unordered categories. For components formed other variables, the starting values are all (approximately) the zero point of the new components scores. Since the baseline is selected by the algorithm using no information of the substantively interesting or important values or combinations of values, the baseline estimate is merely a point from which to start a conversation about what are the effects of the explanatory variables on the estimated probability each respondent designs a particular type of drive train. The baseline probability estimates are shown at the top of Table B8, followed by estimates based on the changes to the values of the explanatory variables described in each row of the table. The highest probability in each row is highlighted in **bold**: this is the drivetrain the model "predicts" for the respondents with the combination of values described by that row. Only a few examples of changes to explanatory variables are provided:

1. Effects of changing values of those variables shown to have high importance in Table 7a,
2. A set of values made up of the modal (most frequent) values of discrete variables and the median values of continuous explanatory variables,
3. Examples of values that produce estimates of BEV and FCEV designs, and
4. The profile of explanatory variables that maximizes the probability that a BEV is designed.

The first changes in Table 8b illustrate that many changes in values of explanatory variables produce shifts between whether ICEVs and HEVs are the most likely outcome rather than large enough increases in the probability of designing PHEVs, BEVs, or FCEV that one of these has the highest probability. So, while differences such as whether or not people already consider electricity or hydrogen to be likely replacements for gasoline and diesel and whether there is electricity available at their home parking location are associated with increasing likeliness to design a PHEVs, BEVs, or FCEVs, they are not by themselves sufficient to increase the likeliness enough to make PEVs or FCEVs the most likely predicted outcome.

Examples of other changes to the values of explanatory variables required to produce probabilities that PEVs or FCEVs are the most likely designs include only that the respondent believe that government should offer incentives for alternatives to gasoline and diesel and that they have a high level of interest in ZEV technology. Also from the starting point of the "frequent/modal" variable profile in Table 8b differences in Prior BEV Components 2 (driving range-charging time), Driving Experience Components 1 (PHEVs, BEVs, and FCEVs), and Familiarity Components 1 (HEVs, PHEVs, BEVs, and FCEVs) make comparatively large differences in the probability of designing a BEV. However, it requires large changes in all three values plus other changes to shift the drivetrain design probabilities to the point where the probabilities of designing an HEV (29.7%), PHEV (27.7%), or BEV (27.9%) approach parity. Prior BEV Components 2 must be reduced to its 10^{th} percentile value (strong disagreement that BEV driving range is too short and charging times too long). Prior Driving Experience Components 1 and Familiarity Components 1 must be increased to their 90^{th} percentile values (very high levels of driving experience with PHEVs, BEVs, or FCEVs and familiarity with HEVs, PHEVs, BEVs, and FCEVs). The further changes are to shift from people who have 110V electrical service at their home parking location to those who have 220V service and those who have already at least looked for information about PEVs. If we move to people who have also at least searched for information about vehicles powered by hydrogen, the design probabilities tip nearly imperceptibly in favor of BEVs (BEVs 30.9% vs. HEVs 30.8%).

Table B8: Probability distribution of drivetrain designs, profiles of explanatory variables

Drivetrain type:	ICEV	HEV	PHEV	BEV	FCEV
Baseline probability estimates, %	**46.8**	31.1	8.0	10.7	3.4
Changes to base values of explanatory variables	**Revised Probability Estimates, %**				
Replacement: Electricity, *No to Yes*	29.2	**41.3**	11.5	13.4	4.6
Replacement: Hydrogen, *No to Yes*	**37.5**	33.4	8.9	12.9	7.4
Replacement: Electricity and Hydrogen, *No to Yes*	22.0	**41.6**	12.0	15.1	9.3
Highest Home PEV Charging Access, *No to 220V*	**41.7**	21.0	12.8	19.0	5.5
Plus Replacement: Electricity, *No to Yes*	25.1	**26.9**	17.8	23.0	7.2
Prior Consideration of a BEV, *Gathered info/shopped/own to Idea has occurred, but no real steps taken*	**43.7**	38.5	7.6	6.2	4.0
Plus Highest Home PEV Access, *No to 220V*	**41.2**	27.5	12.9	11.6	6.9
Plus Replacement: Electricity, *No to Yes*	24.6	**34.9**	17.7	13.9	8.9
Household described by the modal and median values	14.7	**49.1**	27.8	6.4	2.0
Replacement: Electricity, *Yes*					
Replacement: Hydrogen, *No*					
Highest Home PEV Charging Access, *110V*					
Home Natural Gas, *Yes*					
Familiarity Components1 (HEVs, PHEVs, BEVs, FCEVs), 0.166					
Familiarity Components2 (ICEVs), 0.085					
Driving Experience Components 1 (PHEVs, BEVs, FCEVs), -0.333					
Driving Experience Components 2 (HEVs), -0.291					
Prior BEV Components1 (safety-reliability), 0.032					
Prior BEV Components 2 (driving range-charging time), 0.019					
Prior FCEV Components 2 (driving range-fueling time), 0.00					
Prior Consideration of an PEV, *Idea has occurred, but no real steps taken*					
Prior Consideration of an FCEV, *Have not considered an FCEV, but may someday*					
Should government offer incentives, *Yes both electricity and hydrogen*					
Seen Public EVSEs, *Yes*					
Personal interest in ZEV technology, *A little interested*					
Environment Components 1b (Regional and personal AQ), -0.129					

Drivetrain type:	ICEV	HEV	PHEV	BEV	FCEV
Baseline probability estimates, %	**46.8**	31.1	8.0	10.7	3.4
Changes to base values of explanatory variables	**Revised Probability Estimates, %**				
A household estimated to design a BEV: Change these values from the "frequent and median values" profile above to the new values shown here: Highest Home PEV Charging Access, *220V* Prior Consideration of a BEV, *Gathered info/shopped/own* Prior Consideration of an FCEV, *Gathered info/shopped/own* Should government offer incentives: *Yes, but only electricity* Personal interest in ZEV technology: *Very interested*	5.9	16.0	25.0	**39.8**	13.3
A household estimated to design an FCEV: Change these values from the "BEV household" above: Prior consideration of a BEV, *Have not and would not consider a BEV for my household.* Should government offer incentives: *Yes but only hydrogen*	6.9	26.0	26.3	6.1	**34.8**
Values that maximize the probability of a BEV Replacement Electricity: *No or yes* Replacement Hydrogen: *Yes* Highest Home PEV Charging Access: *220V* Home natural gas: *No* Consider PEVs: *Gather information/shopped/own a BEV* Consider FCEVs: *Have not, and would not, consider an FCEV* Government should offer consumer incentives: *Yes, but only for electricity* Seen Public EVSE: *Yes* Personal interest in ZEV technology: *None to some* Environment Components 1b: Virtually no difference across the entire scale Driving experience Components 2: *High experience driving HEVs* Driving experience Components 1: *High experience driving PHEVs, BEVs, or FCEVs* Familiarity Components 1: *High familiarity with HEVs, PHEVs, BEVs, and/or FCEVs* Familiarity Components 2: *High familiarity with ICEVs* Prior BEV Components 1: *Low score, i.e., PEVs more*	0.1	1.5	3.1	**94.2**	0.1

Drivetrain type:	ICEV	HEV	PHEV	BEV	FCEV
Baseline probability estimates, %	**46.8**	31.1	8.0	10.7	3.4
Changes to base values of explanatory variables	**Revised Probability Estimates, %**				
reliable and safer than ICEVs					
Prior BEV Components 2: *Low score, i.e., disagree PEV range too short and charging times too long*					
Prior FCEV Components 2: *Low score, i.e., disagree FCEV range too short and charging times too long*					

APPENDIX C: EXPLANATORY VARIABLES FROM NOMINAL LOGISTIC REGRESSIONS FOR ALL STATES AND THE NESCAUM REGION

States	Variables
1. Respondent and household Socio-economic and Demographic Measures	
California, Oregon, Washington, Maryland, Delaware, New Jersey, and Massachusetts	• None
New York, NESCAUM	• Gender
NESCAUM	• Education
2. Respondent and Household Vehicles, Travel, and Residences	
Oregon, New Jersey and NESCAUM	• Commutes to work in household vehicle
Oregon	• Price paid for most recent new vehicle • Respondent's own monthly fuel spending • Fuel economy of vehicle respondent drives most often • Daily flexibility in assigning vehicles to different drivers
New York	• Monthly miles driven by respondent
California, Washington, Delaware and Massachusetts	• Highest level of electrical service at parking location
NESCAUM	• Park at home in garage or carport
Massachusetts	• Install a PEV charger at their residence on their own authority or would require permission from another party
California	• Natural gas at residence
3. Attitudes related to policy goals: air quality, energy security, and global warming	
California, Maryland and, Massachusetts	• Air pollution a regional threat and personal risk
New York and	• Air pollution a personal risk

Washington Oregon	• Individual lifestyle affects air quality
California and New Jersey	• Should government offer incentives for electricity and/or hydrogen
Delaware and New Jersey	• Heard of federal incentives for alternatives to gasoline and diesel
NESCAUM	• Urgent national need for transition to alternative fuels
NESCAUM	• Comparative risk to environment and human health of electricity and gasoline "in your region"
4. Prior ZEV Evaluation and Experience; ZEV-specific attitudes	
California, Oregon, Washington and, Delaware	• Prior belief electricity is a likely replacement for gasoline and diesel
California, New Jersey, Massachusetts and NESCAUM	• Prior belief hydrogen is a likely replacement for gasoline and diesel
California, Delaware, New Jersey, New York and NESCAUM	• Personal interest in ZEV technology
Washington	• Technophile at home
California and Oregon	• Familiarity with HEVs, PHEVs, EVs, and FCEVs
Washington	• Familiarity with HEVs
California, New Jersey and NESCAUM	• Familiarity with ICEVs
California, Massachusetts, New Jersey, Washington and NESCAUM	• Relative reliability and safety of EVs and ICEVs
California, Oregon and NESCAUM	• Driving range and charging time of PEVs
Maryland	• Extent of away-from-home PEV charging

NESCAUM	• Ability to charge PEV at home and extent of away-from-home PEV charging
NESCAUM	• Relative purchase price of PEVs vs. ICEVs
California	• Driving range and fueling time of FCEVs
California and New Jersey	• Driving Experience: PHEV, BEV, or FCEV
California and NESCAUM	• Driving Experience: HEV
California, Massachusetts, New Jersey, New York, Washington and NESCAUM	• Seen charging for PEVs at (non-residential) parking facilities they use
California, Delaware, Oregon, Maryland, Massachusetts, New Jersey, New York and NESCAUM	• Whether they have already considered buying an PEV
California, Massachusetts, New York Washington and NESCAUM	• Whether they have already considered buying an FCEV

APPENDIX D: ANALYTICAL METHODS AND DETAILS

Logistic Regression Models

Logistic regression uses a function of the following form to predict the probability that observation *i* has outcome *j* (where *j* belongs to the set *J* of all possible outcomes), for example, that a respondent (identified as *i*) designs their next new vehicle to be a BEV out of the *j* = 5 possible outcomes {ICEV, HEV, PHEV, BEV, FCEV}:

$$f(j,i) = \beta_{0,j} + \beta_{1,j}x_{1,i} + \beta_{2,j}x_{2,i} + \ldots + \beta_{M,j}x_{M,i,},$$

where $\beta_{M,k}$ is the parameter (that is to be estimated) associated with the *m*th explanatory variable and the *j*th outcome.

In the case of a simple logistic regression, e.g., the only two possible outcomes are the household designs their next new vehicle to be a PEV or an ICEV, *f(j,i)* is written as the ratio of the natural logarithms of the probabilities that either of the two outcomes occurs:

$$\ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 x_{1,i} + \beta_2 x_{2,i} + \cdots + \beta_M x_{M,i}$$

where p_i is the probability that a household designs their next new vehicle to be a PEV (and thus $1-p_i$ is the probability it is an ICEV).

The interpretation of the estimated parameters β_j is the additive effect on the logarithm of the odds for a unit change in the *j*th explanatory variable. For the simple case of an explanatory variable that has only two values, the parameter estimates the change in the odds of the outcome *i* occurring between those two values. For example, if β_j is the parameter for whether or not the household has a place to charge a PEV at home (coded as no or yes), the parameter estimates the change in the odds of the household designing their next vehicle to be a PEV depending on whether they don’t or do have access to vehicle charging at home. If the statistical model is doing a good job of matching the data and our knowledge of the world, we would expect the parameter for access to home charging to be positive and statistically significantly different from zero, i.e., we expect that home access to charging should increase the odds a household would design their next new vehicle to be a PEV compared to an otherwise similar household that does not have access to vehicle recharging at home. Extensions to cases with more than two possible outcomes, i.e., more than two types of vehicle propulsion systems, result in similar interpretations of the model parameters.

Implementation in this study

The dependent variable in this study is the drivetrain type of the vehicle designed in the final design game. For each respondent’s combination of values of the explanatory variables (the *x*’s in the equations above), the model estimates a probability for each of the five drivetrain types. The model assigns the drivetrain with the highest estimated probability as that respondent’s estimated design.

The description of who designs their next new vehicle to be an ICEV, HEV, PHEV, BEV, or FCEV begins with the search for simple correlations between respondents' drivetrain designs from the final design game and several potential descriptors of respondents, their other household members, their vehicles, travel, and residences. The set of possible explanatory variables is summarized in Appendix A. For each potential explanatory variable, i.e., independent variable, an alternative hypothesis is stated. These hypotheses are alternatives to the standard null hypothesis (H_o). In statistical jargon, null hypotheses are stated as no affect, e.g., for the number of vehicles owned by each household, the null hypothesis is that how many vehicles a household already owns has no affect on whether they design their next new vehicle to be a BEV, PHEV or FCEV. For ZEVs with driving range limits, prior research indicates that households with more vehicles have more options for those instances when a driving range limit would prevent a BEV from making a trip. Thus the alternative hypothesis can be stated that the more vehicles a household owns, the more likely it is to design its next new vehicle to be a BEV (and thus a ZEV). As many of the null hypotheses have previously been stated, we do not bother to repeat them for each dependent variable in the table. The statistical tests of significance to reject the null hypothesis of no affect is set to $\alpha = 0.05$. The acceptance or rejection of any null or alternative hypothesis in Appendix A is only in regards to the bivariate relationship between each explanatory variable—taken one at a time—and the dependent variable, that is, drivetrain design in the third design game. The results in Appendix A guide the construction of the multivariate model, i.e., the model that that contains more than one explanatory variable.

Choosing explanatory variables

Several of the simple correlations between possible explanatory variables and the drivetrain of the vehicle designed in the final survey game (ICEV, HEV, PHEV, BEV, or FCEV) surpass the level of significance set for rejection/non-rejection. However, many of the possible explanatory variables are correlated to each other as well as to the final drivetrain design, e.g., concerns with air quality are correlated with concerns about climate change: people concerned about one are more likely to be concerned about the other. Such correlations between explanatory variables produce difficulties in estimating multivariate models (models containing more than one explanatory variable).

Further, several questions about a single topic may plausibly be reduced to a smaller number of dimensions. For example, we ask seven questions about respondents' prior evaluation of BEVs: ability to charge one at home, the extent of the away-from-home charging network, time to charge a BEV, driving range, purchase price, cost to charge, safety and reliability compared to gasoline vehicles. It may be the case that these seven questions can be represented by a smaller number of linear combinations, say, one for cost, one for charging, etc. If so, then those components may be better explanations of ZEV valuation than the original questions.

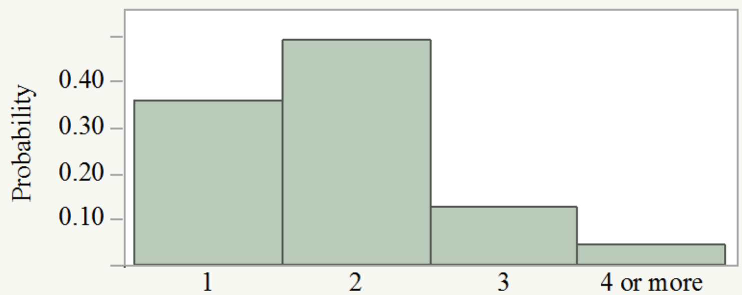
We review those variables, identify the concepts they represent, and choose potential variables from each concept to represent each concept. Variables are selected for either (or both) substantive interest or statistical strength of the bivariate correlation. The resulting multivariate model is thus only one of many that could be produced. This is not to say that statistical models can be made to say anything, but to construct a model that allows for tests of important concepts. The numerical details of the final estimated model are presented in Appendix B.

APPENDIX E: FREQUENCIES OF SURVEY RESPONSES

Distributions are presented in the order the questions were asked in the questionnaire. As such, this appendix closes with the open-ended comments left by respondents. Comments have been lightly-edited for typography and cataloged by topic areas.

Household Vehicles

Number of vehicles

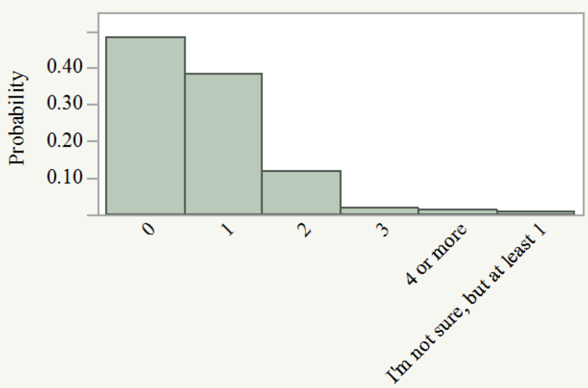


Frequencies

Level	Count	Prob
1	593	0.35488
2	810	0.48474
3	200	0.11969
4 or more	68	0.04069
Total	1671	1.00000

N Missing 0
4 Levels

Number as Used since 1/08

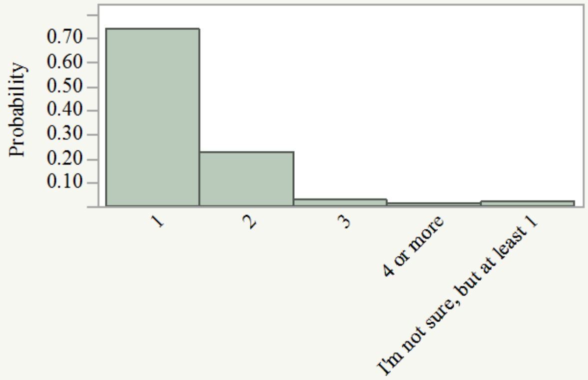


Frequencies

Level	Count	Prob
0	800	0.47876
1	632	0.37822
2	193	0.11550
3	25	0.01496
4 or more	15	0.00898
I'm not sure, but at least 1	6	0.00359
Total	1671	1.00000

N Missing 0
6 Levels

Number as New since 1/08

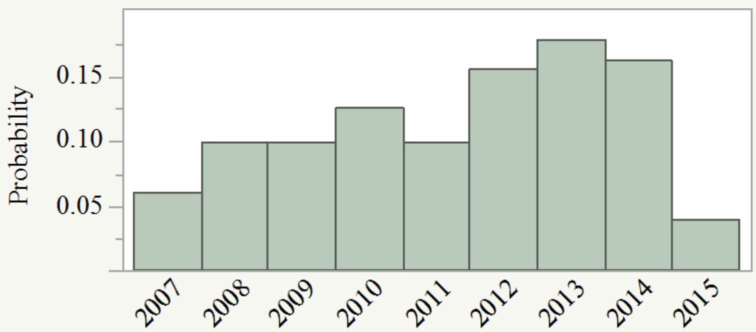


Frequencies

Level	Count	Prob
1	1222	0.73130
2	372	0.22262
3	42	0.02513
4 or more	10	0.00598
I'm not sure, but at least 1	25	0.01496
Total	1671	1.00000

N Missing 0
5 Levels

Model Year Most Recently Acquired



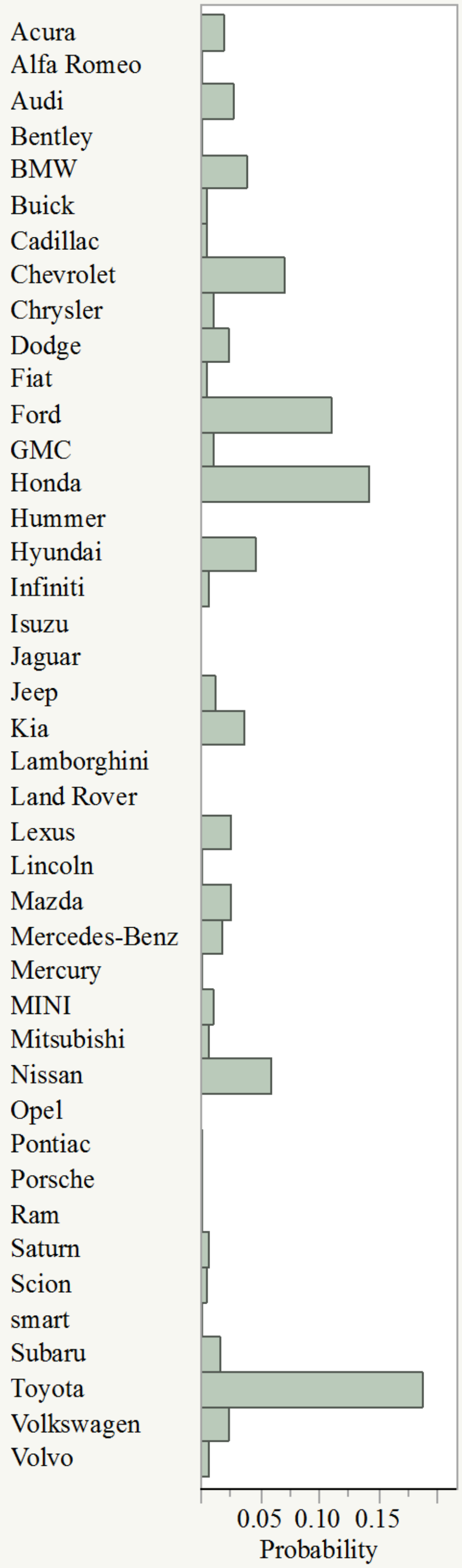
Frequencies

Level	Count	Prob
2007	96	0.05745
2008	162	0.09695
2009	161	0.09635
2010	206	0.12328
2011	163	0.09755
2012	256	0.15320
2013	295	0.17654
2014	269	0.16098
2015	63	0.03770
Total	1671	1.00000

N Missing 0
9 Levels

"Veh 1" is the vehicle most recently acquired as new.

Veh 1 Make



Frequencies

Level	Count	Prob
Acura	33	0.01981
Alfa Romeo	3	0.00180
Audi	48	0.02881
Bentley	3	0.00180
BMW	67	0.04022
Buick	9	0.00540
Cadillac	9	0.00540
Chevrolet	120	0.07203
Chrysler	18	0.01080
Dodge	41	0.02461
Fiat	10	0.00600
Ford	184	0.11044
GMC	20	0.01200
Honda	240	0.14406
Hummer	1	0.00060
Hyundai	80	0.04802
Infiniti	14	0.00840
Isuzu	1	0.00060
Jaguar	1	0.00060
Jeep	22	0.01321
Kia	63	0.03782
Lamborghini	1	0.00060
Land Rover	1	0.00060
Lexus	45	0.02701
Lincoln	2	0.00120
Mazda	43	0.02581
Mercedes-Benz	31	0.01861
Mercury	2	0.00120
MINI	19	0.01140
Mitsubishi	11	0.00660
Nissan	99	0.05942
Opel	1	0.00060
Pontiac	2	0.00120
Porsche	2	0.00120
Ram	4	0.00240
Saturn	11	0.00660
Scion	10	0.00600
smart	3	0.00180
Subaru	27	0.01621
Toyota	314	0.18848
Volkswagen	40	0.02401
Volvo	11	0.00660
Total	1666	1.00000

N Missing 5
42 Levels

Veh 1 Buy-Lease

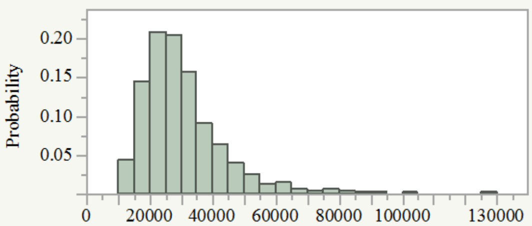
Frequencies

Level	Count	Prob
Bought	1425	0.85278
Leased	218	0.13046
Other	28	0.01676
Total	1671	1.00000

N Missing 0

3 Levels

Veh 1 Total Price



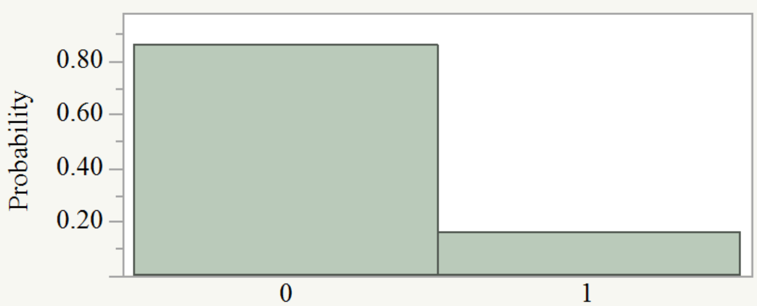
Quantiles

100.0%	maximum	125500
99.5%		80175
97.5%		60000
90.0%		44750
75.0%	quartile	35000
50.0%	median	27000
25.0%	quartile	21000
10.0%		17500
2.5%		12999.9913
0.5%		10000
0.0%	minimum	10000

Summary Statistics

Mean	29176.981
Std Dev	11945.355
Std Err Mean	323.43861
Upper 95% Mean	29811.472
Lower 95% Mean	28542.489
N	1364

Veh 1 Total Price, don't know



Frequencies

Level	Count	Prob
0	1419	0.84970
1	251	0.15030
Total	1670	1.00000

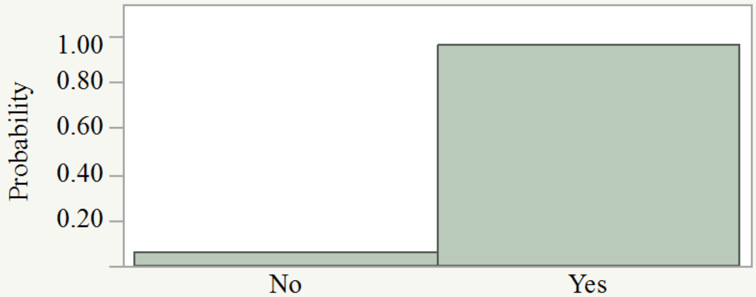
N Missing 1

2 Levels

0 = not asked because a price was given; 1 = don’t know

Fuel type, multiple answers allowed.

Veh 1 Gasoline

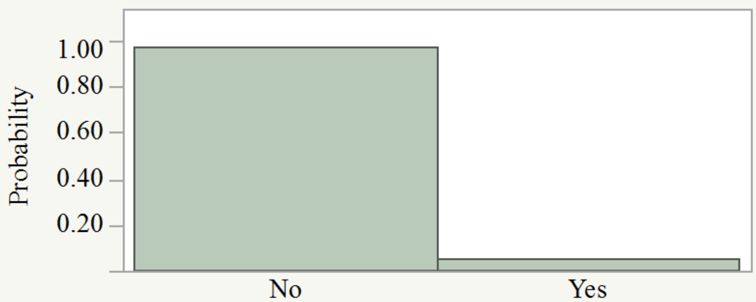


Frequencies

Level	Count	Prob
No	82	0.04907
Yes	1589	0.95093
Total	1671	1.00000

N Missing 0
2 Levels

Veh 1 Diesel

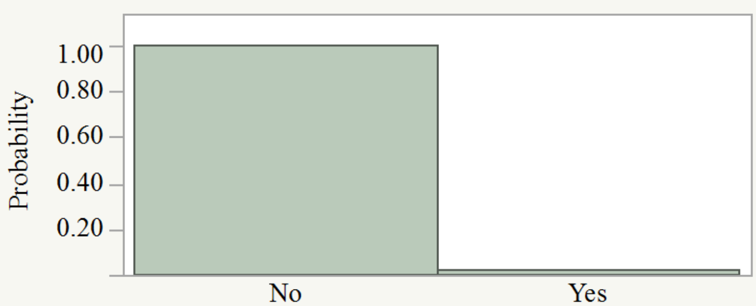


Frequencies

Level	Count	Prob
No	1605	0.96050
Yes	66	0.03950
Total	1671	1.00000

N Missing 0
2 Levels

Veh 1 Ethanol



Frequencies

Level	Count	Prob
No	1651	0.98803
Yes	20	0.01197
Total	1671	1.00000

N Missing 0
2 Levels

Veh 1 Electricity

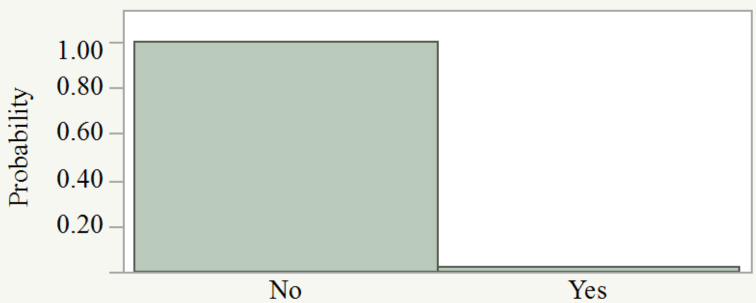
Frequencies

Level	Count	Prob
No	1597	0.95572
Yes	74	0.04428
Total	1671	1.00000

N Missing 0

2 Levels

Veh 1 Natural gas



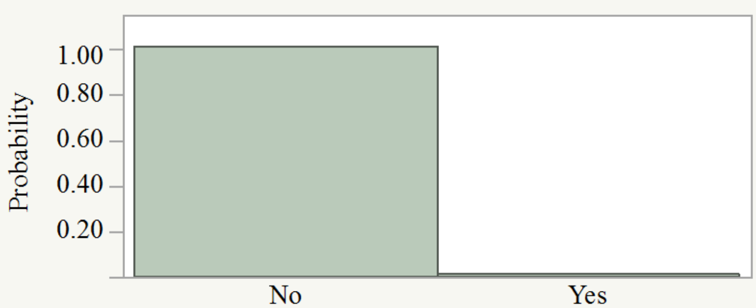
Frequencies

Level	Count	Prob
No	1652	0.98863
Yes	19	0.01137
Total	1671	1.00000

N Missing 0

2 Levels

Veh 1 Hydrogen



Frequencies

Level	Count	Prob
No	1664	0.99581
Yes	7	0.00419
Total	1671	1.00000

N Missing 0

2 Levels

Veh 1 Don't know fuel

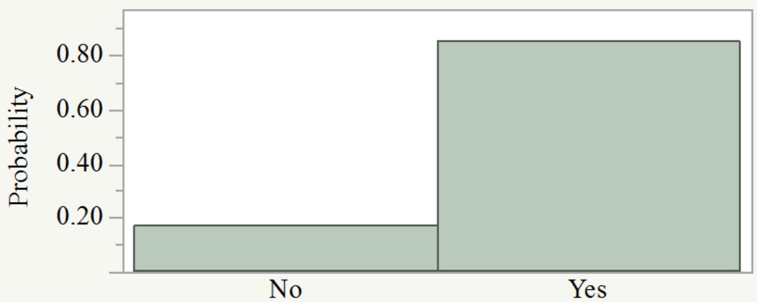
Frequencies

Level	Count	Prob
No	1666	0.99701
Yes	5	0.00299
Total	1671	1.00000

N Missing 0
2 Levels

There were seven responses to “other” fuel type for Vehicle 1.

Respondent drives Veh 1 most often



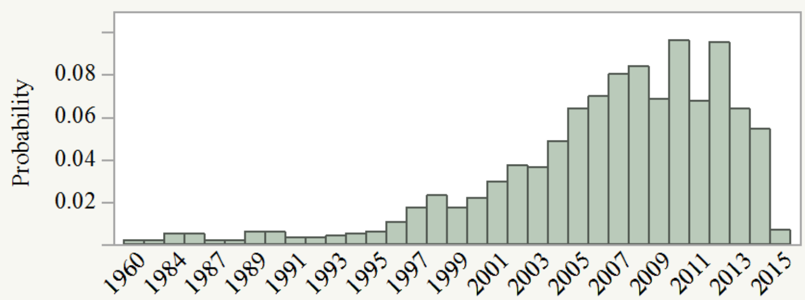
Frequencies

Level	Count	Prob
No	263	0.15739
Yes	1408	0.84261
Total	1671	1.00000

N Missing 0
2 Levels

Given a household owns or leases more than one vehicle, then regardless of whether it was acquired new or used **Veh 2** is either the other vehicle in two vehicle households or the vehicle other than **Veh 1** (the vehicle most recently acquired as new) that is driven the most often in households that have three or more vehicles.

Veh 2 Year

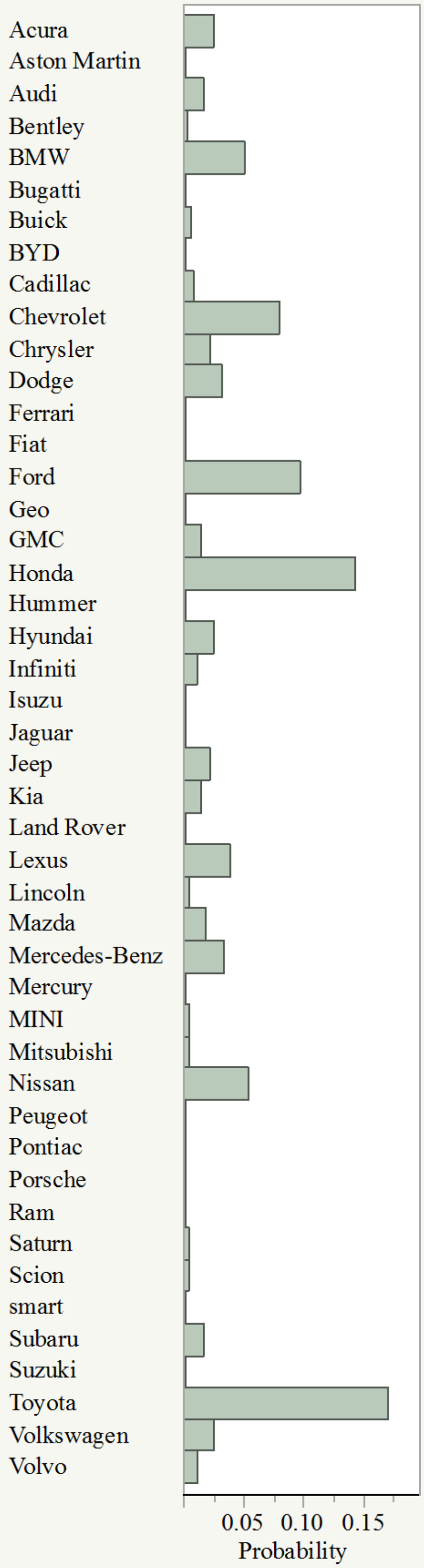


Frequencies

Level	Count	Prob
1960	1	0.00093
1965	1	0.00093
1984	4	0.00372
1986	4	0.00372
1987	1	0.00093
1988	1	0.00093
1989	5	0.00465
1990	5	0.00465
1991	2	0.00186
1992	2	0.00186
1993	3	0.00279
1994	4	0.00372
1995	5	0.00465
1996	10	0.00929
1997	17	0.01580
1998	23	0.02138
1999	17	0.01580
2000	22	0.02045
2001	31	0.02881
2002	39	0.03625
2003	38	0.03532
2004	51	0.04740
2005	67	0.06227
2006	73	0.06784
2007	85	0.07900
2008	89	0.08271
2009	72	0.06691
2010	102	0.09480
2011	71	0.06599
2012	101	0.09387
2013	67	0.06227
2014	57	0.05297
2015	6	0.00558
Total	1076	1.00000

N Missing 595
33 Levels

Veh 2 Make



Frequencies

Level	Count	Prob
Acura	27	0.02512
Aston Martin	1	0.00093
Audi	19	0.01767
Bentley	3	0.00279
BMW	55	0.05116
Bugatti	2	0.00186
Buick	8	0.00744
BYD	1	0.00093
Cadillac	10	0.00930
Chevrolet	86	0.08000
Chrysler	23	0.02140
Dodge	35	0.03256
Ferrari	2	0.00186
Fiat	1	0.00093
Ford	105	0.09767
Geo	1	0.00093
GMC	17	0.01581
Honda	155	0.14419
Hummer	1	0.00093
Hyundai	27	0.02512
Infiniti	13	0.01209
Isuzu	2	0.00186
Jaguar	2	0.00186
Jeep	23	0.02140
Kia	16	0.01488
Land Rover	2	0.00186
Lexus	42	0.03907
Lincoln	5	0.00465
Mazda	20	0.01860
Mercedes-Benz	36	0.03349
Mercury	1	0.00093
MINI	6	0.00558
Mitsubishi	6	0.00558
Nissan	59	0.05488
Peugeot	1	0.00093
Pontiac	2	0.00186
Porsche	1	0.00093
Ram	1	0.00093
Saturn	6	0.00558
Scion	6	0.00558
smart	1	0.00093
Subaru	19	0.01767
Suzuki	2	0.00186
Toyota	184	0.17116
Volkswagen	27	0.02512
Volvo	13	0.01209
Total	1075	1.00000

N Missing 596
46 Levels

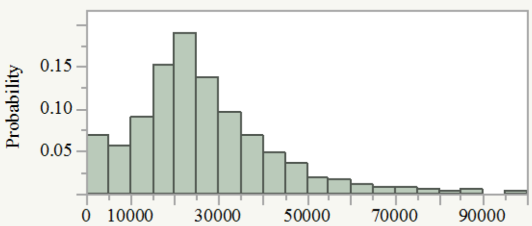
Veh 2 Buy-Lease

Frequencies

Level	Count	Prob
Bought	958	0.88868
Leased	87	0.08071
Other	33	0.03061
Total	1078	1.00000

N Missing 593
3 Levels

Veh 2 Total Price



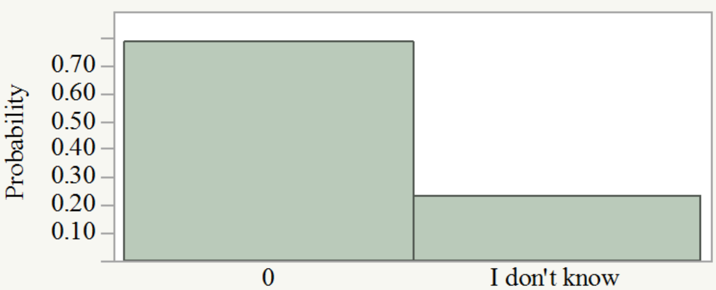
Quantiles

100.0%	maximum	999000
99.5%		688260
97.5%		73075
90.0%		45000
75.0%	quartile	32000
50.0%	median	23000
25.0%	quartile	16000
10.0%		7000
2.5%		1000
0.5%		1.48
0.0%	minimum	0

Summary Statistics

Mean	30190.121
Std Dev	66260.916
Std Err Mean	2291.6817
Upper 95% Mean	34688.255
Lower 95% Mean	25691.988
N	836

Veh 2 Total Price, no idea



Frequencies

Level	Count	Prob
0	836	0.77551
I don't know	242	0.22449
Total	1078	1.00000

N Missing 593
2 Levels

0 = not asked because a price was given.

Fuel type, multiple answers allowed.

rVeh 2 Gasoline

Frequencies

Level	Count	Prob
No	35	0.03247
Yes	1043	0.96753
Total	1078	1.00000

N Missing 593

2 Levels

rVeh 2 Diesel

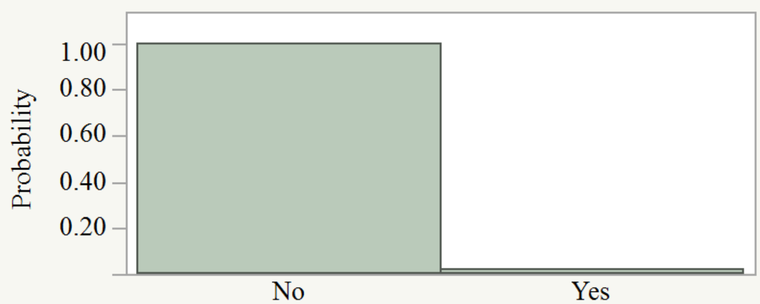
Frequencies

Level	Count	Prob
No	1042	0.96660
Yes	36	0.03340
Total	1078	1.00000

N Missing 593

2 Levels

rVeh 2 Ethanol



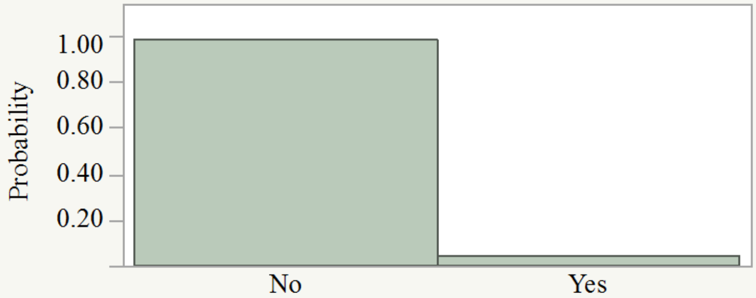
Frequencies

Level	Count	Prob
No	1068	0.99072
Yes	10	0.00928
Total	1078	1.00000

N Missing 593

2 Levels

rVeh2 Electricity

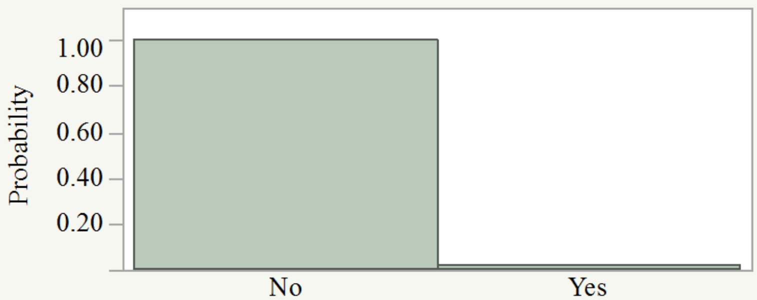


Frequencies

Level	Count	Prob
No	1046	0.97032
Yes	32	0.02968
Total	1078	1.00000

N Missing 593
2 Levels

rVeh2 Natural gas

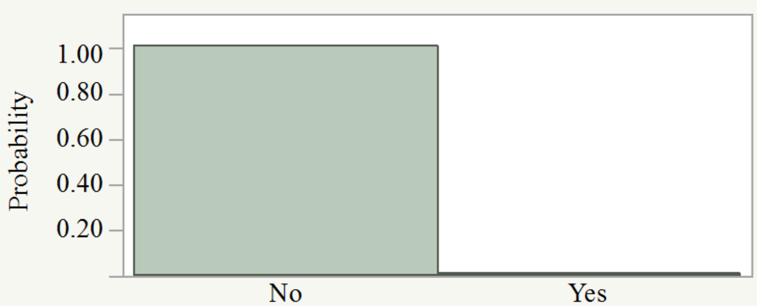


Frequencies

Level	Count	Prob
No	1070	0.99258
Yes	8	0.00742
Total	1078	1.00000

N Missing 593
2 Levels

rVeh 2 Hydrogen



Frequencies

Level	Count	Prob
No	1074	0.99629
Yes	4	0.00371
Total	1078	1.00000

N Missing 593
2 Levels

rVeh 2 don't know fuel

Frequencies

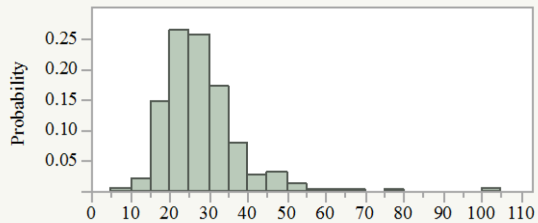
Level	Count	Prob
No	1075	0.99722
Yes	3	0.00278
Total	1078	1.00000

N Missing 593

2 Levels

Fuel economy for Veh 1 (the vehicle driven most often by a respondent) for vehicles fueled by gasoline, diesel, or ethanol. Distribution is truncated at 100 mpg.

Fuel economy, gasoline / diesel / ethanol truncated



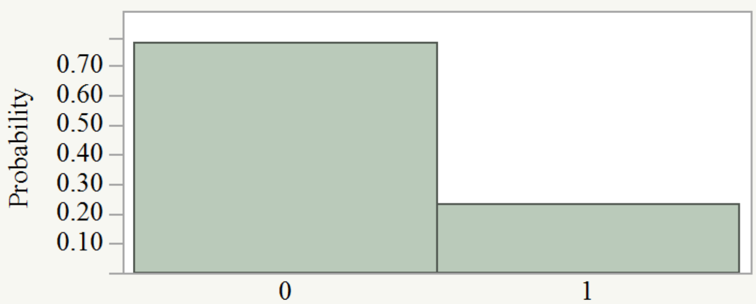
Quantiles

100.0%	maximum	100
99.5%		60.6
97.5%		46.55
90.0%		36
75.0%	quartile	30
50.0%	median	25
25.0%	quartile	21
10.0%		18
2.5%		15
0.5%		10
0.0%	minimum	5

Summary Statistics

Mean	26.616743
Std Dev	8.6458697
Std Err Mean	0.2517977
Upper 95% Mean	27.110765
Lower 95% Mean	26.122721
N	1179

Fuel economy, gasoline / diesel / ethanol, no idea



Frequencies

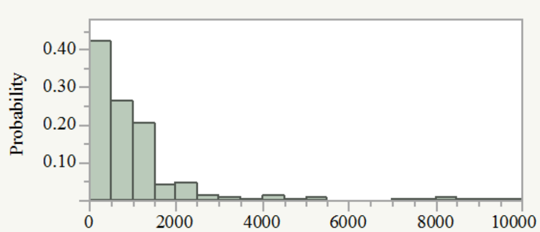
Level	Count	Prob
0	1226	0.77301
1	360	0.22699
Total	1586	1.00000

N Missing 85
2 Levels

0 = not asked because a value was given; 1 = don’t know fuel economy.

Miles driven per month are either reported by the respondent or estimated by multiplying a reported weekly value by four. Distribution is truncated at 10,000 miles per month.

Respondent's vehicle's monthly miles truncated



Quantiles

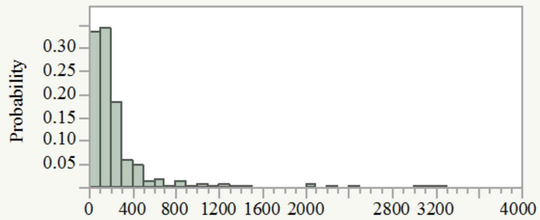
100.0%	maximum	10000
99.5%		8195.86
97.5%		3830
90.0%		1600
75.0%	quartile	1000
50.0%	median	600
25.0%	quartile	280
10.0%		120
2.5%		40
0.5%		15.685
0.0%	minimum	0

Summary Statistics

Mean	845.02279
Std Dev	1069.4747
Std Err Mean	27.288202
Upper 95% Mean	898.54888
Lower 95% Mean	791.49669
N	1536

Spending on fuel for vehicle respondent drives most often, $/month. Values are either reported by the respondent or estimated by multiplying a reported weekly value by four.

Respondent's car fuel spending per month (trunc)



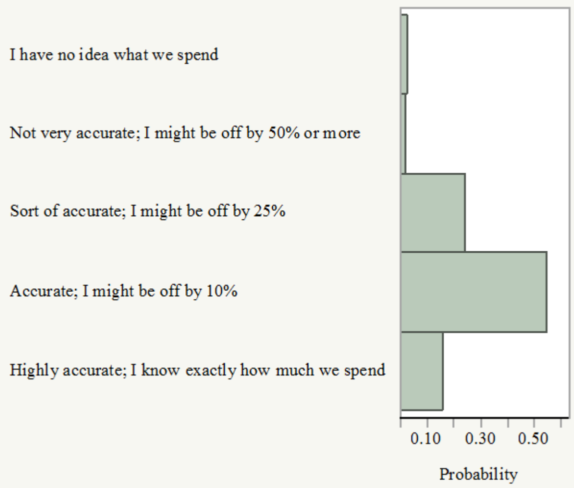
Quantiles

100.0%	maximum	4000
99.5%		2553
97.5%		800
90.0%		351
75.0%	quartile	200
50.0%	median	120
25.0%	quartile	80
10.0%		50
2.5%		30
0.5%		7.3625
0.0%	minimum	0

Summary Statistics

Mean	200.14584
Std Dev	314.38336
Std Err Mean	7.9905022
Upper 95% Mean	215.8192
Lower 95% Mean	184.47248
N	1548

Fuel spending accuracy



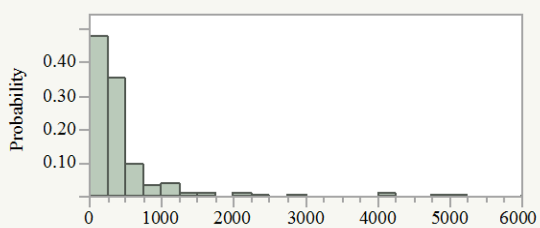
Frequencies

Level	Count	Prob
Highly accurate; I know exactly how much we spend	253	0.15942
Accurate; I might be off by 10%	873	0.55009
Sort of accurate; I might be off by 25%	382	0.24071
Not very accurate; I might be off by 50% or more	37	0.02331
I have no idea what we spend	42	0.02647
Total	1587	1.00000

N Missing 84
5 Levels

Spending on fuel for all household vehicles, $/month. Values are either reported by the respondent or estimated by multiplying a reported weekly value by four.

Total fuel cost per month, truncated



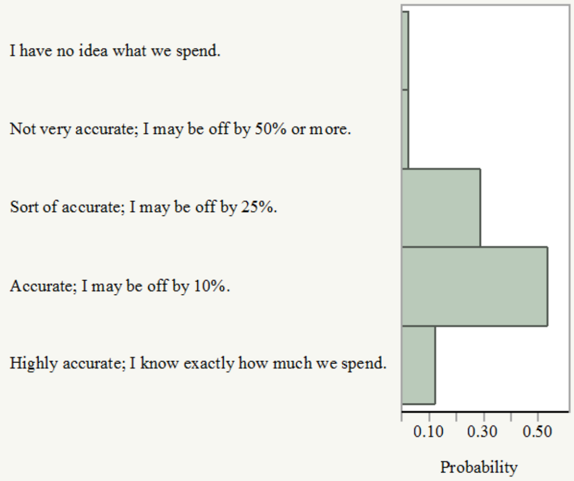
Quantiles

100.0%	maximum	6000
99.5%		4000
97.5%		1281.5
90.0%		600
75.0%	quartile	400
50.0%	median	250
25.0%	quartile	160
10.0%		100
2.5%		45
0.5%		20
0.0%	minimum	0

Summary Statistics

Mean	363.2447
Std Dev	476.215
Std Err Mean	14.79528
Upper 95% Mean	392.27687
Lower 95% Mean	334.21253
N	1036

Total fuel cost accuracy



Frequencies

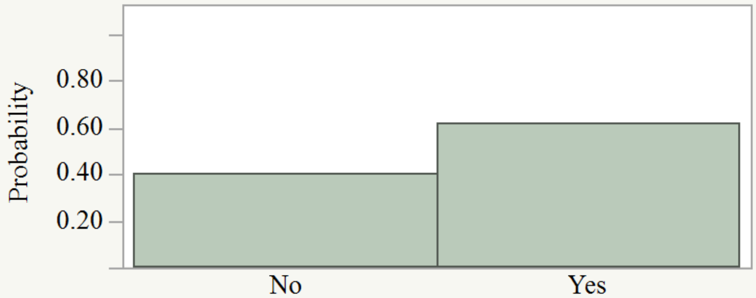
Level	Count	Prob
Highly accurate; I know exactly how much we spend.	133	0.12338
Accurate; I may be off by 10%.	577	0.53525
Sort of accurate; I may be off by 25%.	313	0.29035
Not very accurate; I may be off by 50% or more.	28	0.02597
I have no idea what we spend.	27	0.02505
Total	1078	1.00000

N Missing 593
5 Levels

Likely replacements for gasoline and diesel

Most likely replacements for gasoline and diesel fuel, up to three selected.

Replacement: Electricity

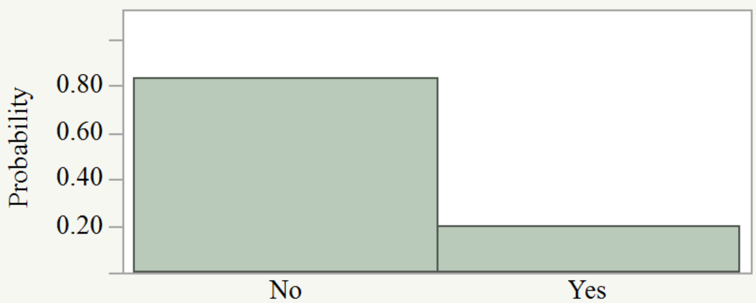


Frequencies

Level	Count	Prob
No	653	0.39078
Yes	1018	0.60922
Total	1671	1.00000

N Missing 0
2 Levels

Replacement: Hydrogen

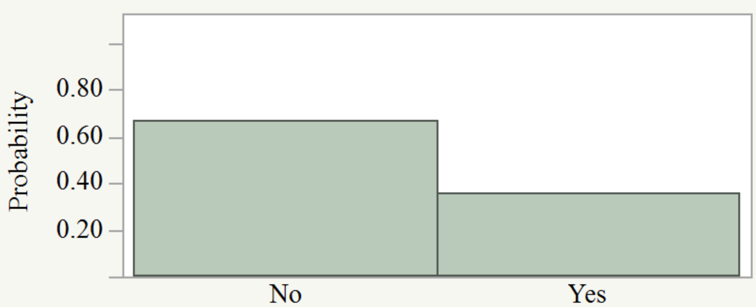


Frequencies

Level	Count	Prob
No	1367	0.81807
Yes	304	0.18193
Total	1671	1.00000

N Missing 0
2 Levels

Replacement: Natural Gas

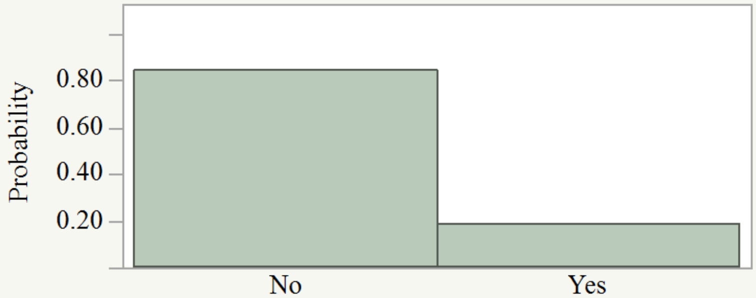


Frequencies

Level	Count	Prob
No	1099	0.65769
Yes	572	0.34231
Total	1671	1.00000

N Missing 0
2 Levels

Replacement: Ethanol

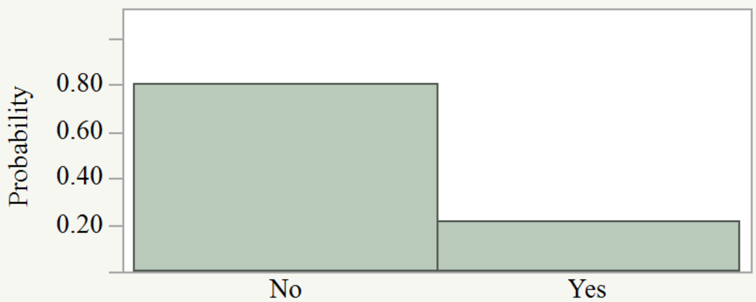


Frequencies

Level	Count	Prob
No	1380	0.82585
Yes	291	0.17415
Total	1671	1.00000

N Missing 0
2 Levels

Replacement: Bio-diesel

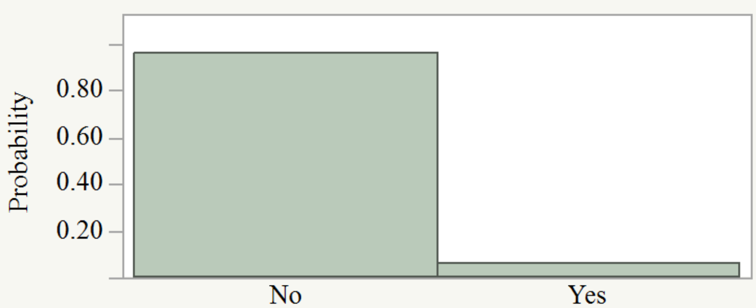


Frequencies

Level	Count	Prob
No	1324	0.79234
Yes	347	0.20766
Total	1671	1.00000

N Missing 0
2 Levels

Replacement: Propane

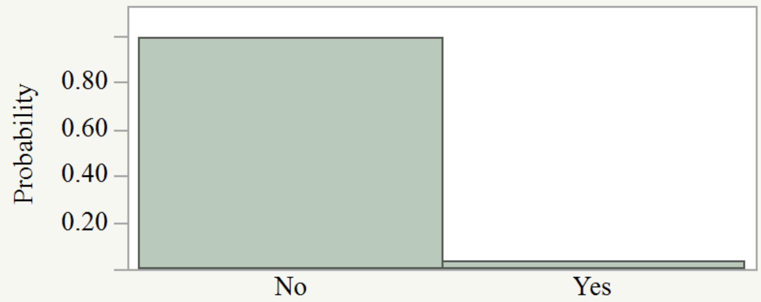


Frequencies

Level	Count	Prob
No	1585	0.94853
Yes	86	0.05147
Total	1671	1.00000

N Missing 0
2 Levels

Replacement: None

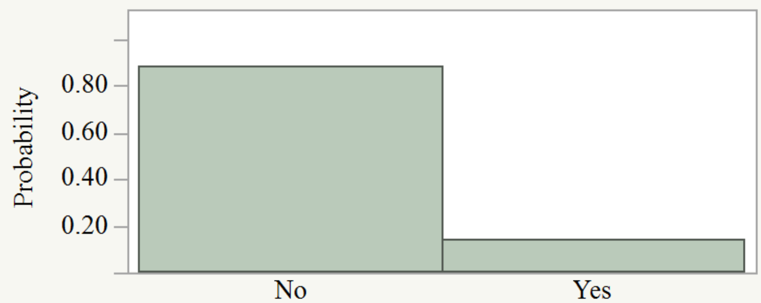


Frequencies

Level	Count	Prob
No	1633	0.97726
Yes	38	0.02274
Total	1671	1.00000

N Missing 0
2 Levels

Replacement: No Idea



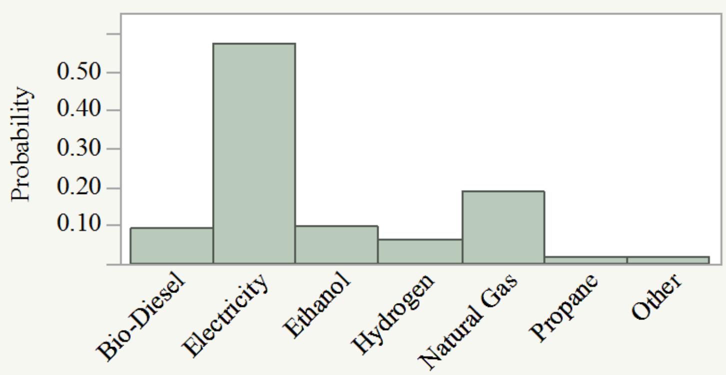
Frequencies

Level	Count	Prob
No	1457	0.87193
Yes	214	0.12807
Total	1671	1.00000

N Missing 0
2 Levels

From the short list of up to three possibilities created by each respondent in the prior questions, which one do they think is the most likely replacement for gasoline and diesel.

Likely replacement



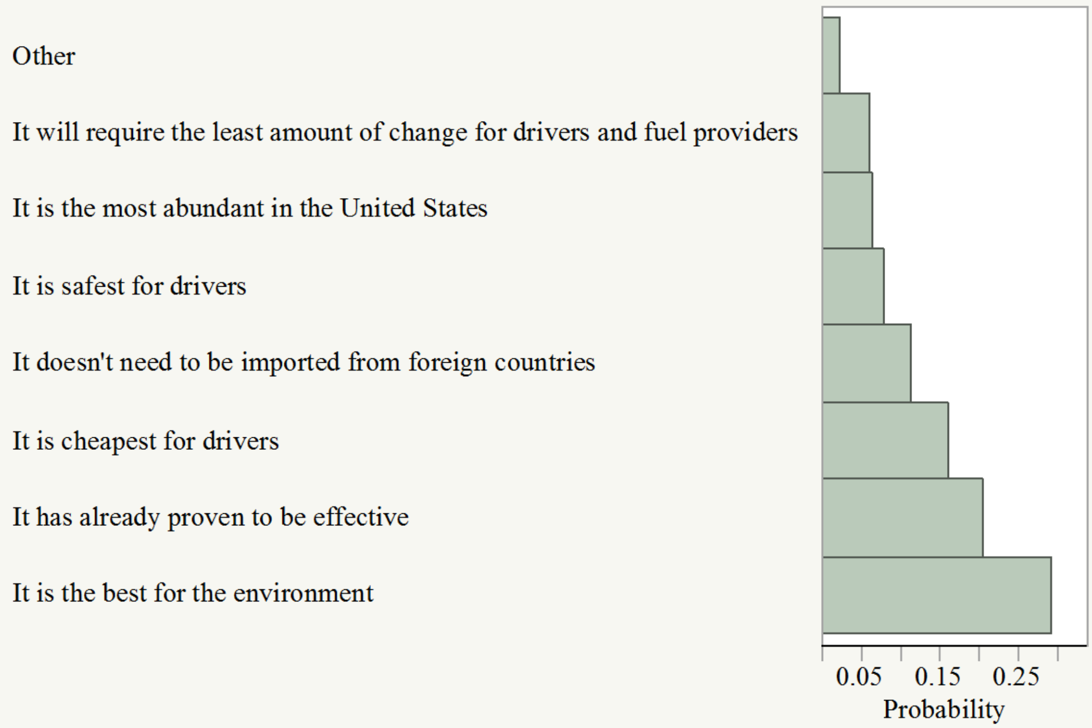
Frequencies

Level	Count	Prob
Bio-Diesel	117	0.08245
Electricity	805	0.56730
Ethanol	129	0.09091
Hydrogen	84	0.05920
Natural Gas	256	0.18041
Propane	15	0.01057
Other	13	0.00916
Total	1419	1.00000

N Missing 252
7 Levels

Reason they believe most likely replacement.

Reason replacement



Frequencies

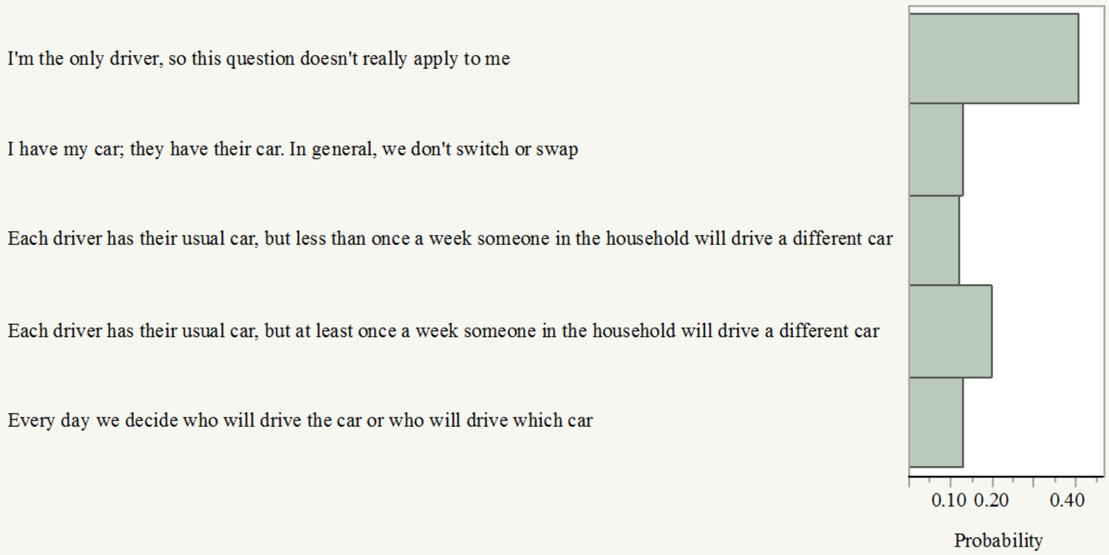
Level	Count	Prob
It is the best for the environment	416	0.29316
It has already proven to be effective	290	0.20437
It is cheapest for drivers	228	0.16068
It doesn't need to be imported from foreign countries	161	0.11346
It is safest for drivers	112	0.07893
It is the most abundant in the United States	91	0.06413
It will require the least amount of change for drivers and fuel providers	89	0.06272
Other	32	0.02255
Total	1419	1.00000

N Missing 252
8 Levels

Driving-related measures

Day-to-day flexibilty of vehicle use within households.

Daily flexibility

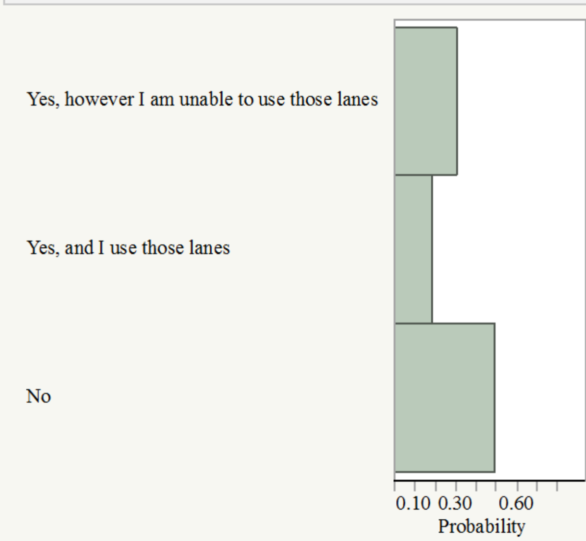


Frequencies

Level	Count	Prob
Every day we decide who will drive the car or who will drive which car	222	0.13285
Each driver has their usual car, but at least once a week someone in the household will drive a different car	335	0.20048
Each driver has their usual car, but less than once a week someone in the household will drive a different car	208	0.12448
I have my car; they have their car. In general, we don't switch or swap	222	0.13285
I'm the only driver, so this question doesn't really apply to me	684	0.40934
Total	1671	1.00000

N Missing 0
5 Levels

HOV lanes

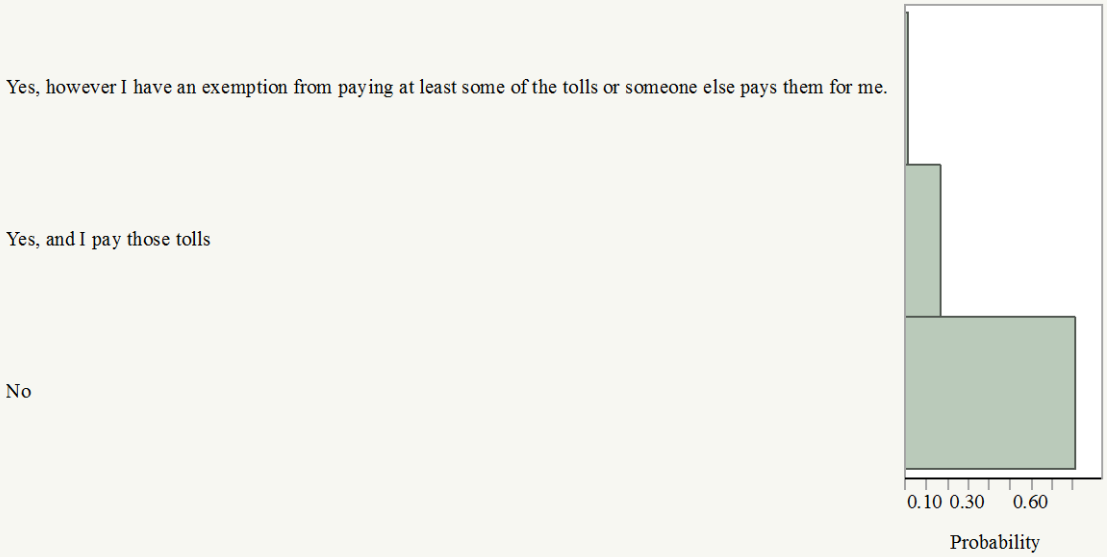


Frequencies

Level	Count	Prob
No	834	0.49910
Yes, and I use those lanes	315	0.18851
Yes, however I am unable to use those lanes	522	0.31239
Total	1671	1.00000

N Missing 0
3 Levels

Toll lanes

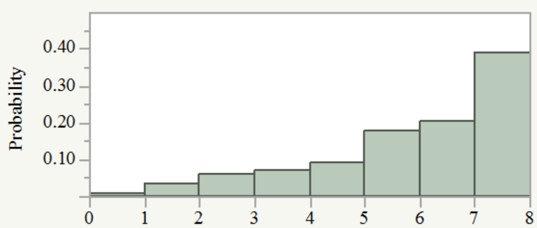


Frequencies

Level	Count	Prob
No	1364	0.81628
Yes, and I pay those tolls	282	0.16876
Yes, however I have an exemption from paying at least some of the tolls or someone else pays them for me.	25	0.01496
Total	1671	1.00000

N Missing 0
3 Levels

Days driving per week, self



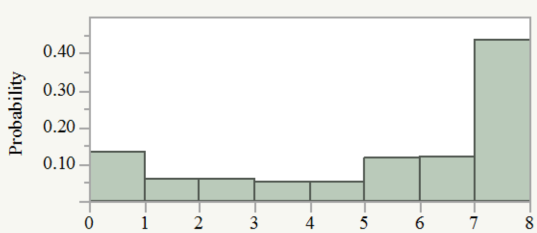
Quantiles

100.0%	maximum	7
99.5%		7
97.5%		7
90.0%		7
75.0%	quartile	7
50.0%	median	6
25.0%	quartile	5
10.0%		3
2.5%		1
0.5%		1
0.0%	minimum	0

Summary Statistics

Mean	5.4446439
Std Dev	1.7304303
Std Err Mean	0.0423317
Upper 95% Mean	5.5276727
Lower 95% Mean	5.3616151
N	1671

Days driving per week, hhld



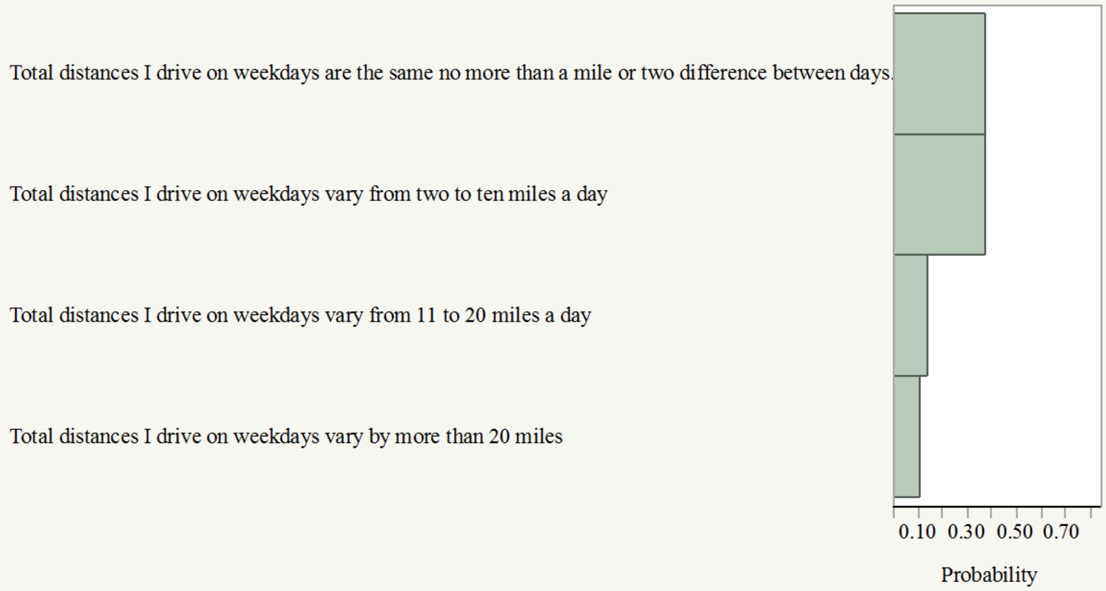
Quantiles

100.0%	maximum	7
99.5%		7
97.5%		7
90.0%		7
75.0%	quartile	7
50.0%	median	6
25.0%	quartile	3
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	4.7971275
Std Dev	2.5825562
Std Err Mean	0.0631774
Upper 95% Mean	4.9210427
Lower 95% Mean	4.6732123
N	1671

Daily distance variation



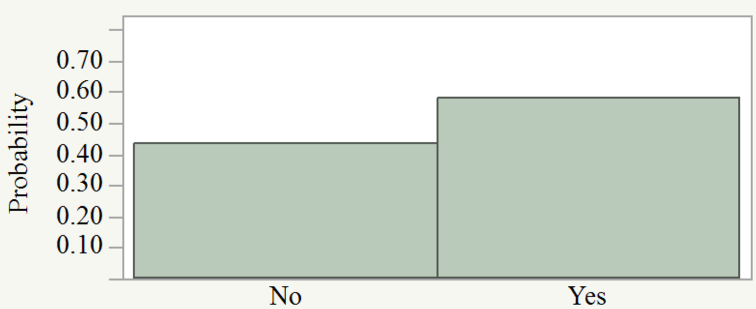
Frequencies

Level	Count	Prob
Total distances I drive on weekdays vary by more than 20 miles	184	0.11051
Total distances I drive on weekdays vary from 11 to 20 miles a day	235	0.14114
Total distances I drive on weekdays vary from two to ten miles a day	618	0.37117
Total distances I drive on weekdays are the same no more than a mile or two difference between days.	628	0.37718
Total	1665	1.00000

N Missing 6
4 Levels

Whether respondent commutes to a workplace.

Commute



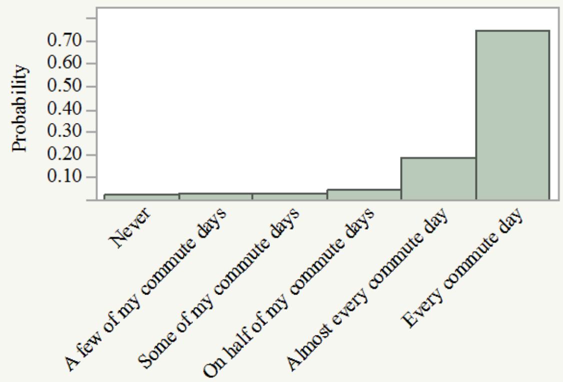
Frequencies

Level	Count	Prob
No	718	0.42968
Yes	953	0.57032
Total	1671	1.00000

N Missing 0
2 Levels

How often is commute made, at least for part of the trip, in a household vehicle. Only asked if respondent commutes to a workplace.

Days commute by car



Frequencies

Level	Count	Prob
Never	11	0.01154
A few of my commute days	19	0.01994
Some of my commute days	21	0.02204
On half of my commute days	37	0.03882
Almost every commute day	165	0.17314
Every commute day	700	0.73452
Total	953	1.00000

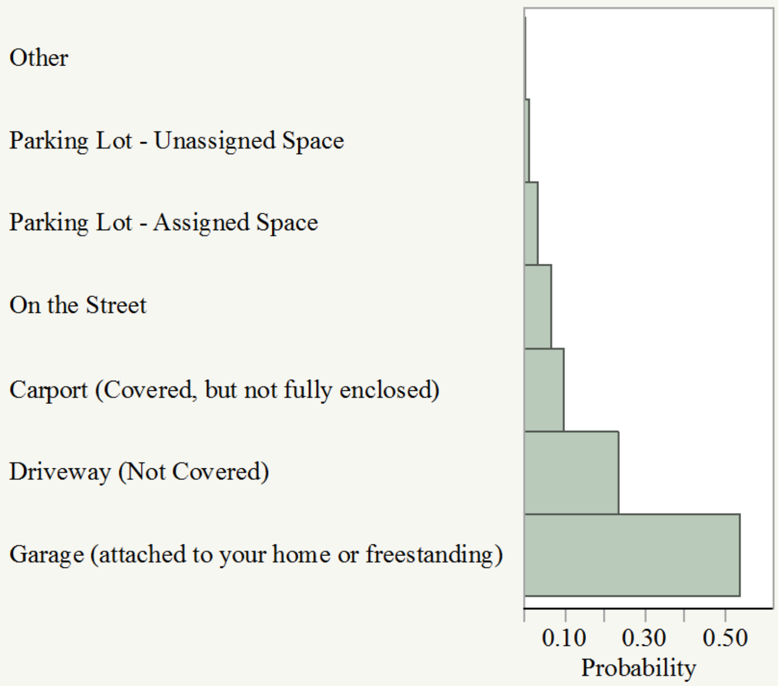
N Missing 718

6 Levels

Home Parking Measures

"Own car" is vehicle respondent drives most often.

Home Park own car



Frequencies

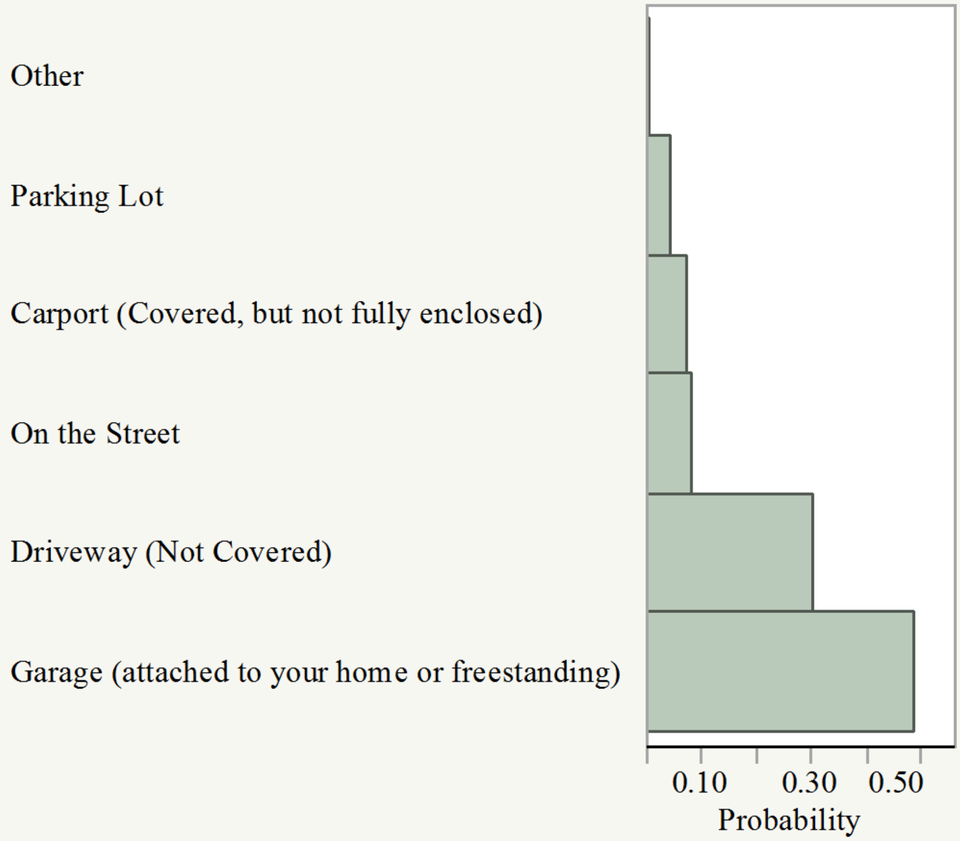
Level	Count	Prob
Garage (attached to your home or freestanding)	898	0.53740
Driveway (Not Covered)	393	0.23519
Carport (Covered, but not fully enclosed)	169	0.10114
On the Street	115	0.06882
Parking Lot - Assigned Space	61	0.03651
Parking Lot - Unassigned Space	27	0.01616
Other	8	0.00479
Total	1671	1.00000

N Missing 0

7 Levels

"Other car" is whichever of Veh 1 or Veh 2 the respondent does not drive most often.

Home Park other car



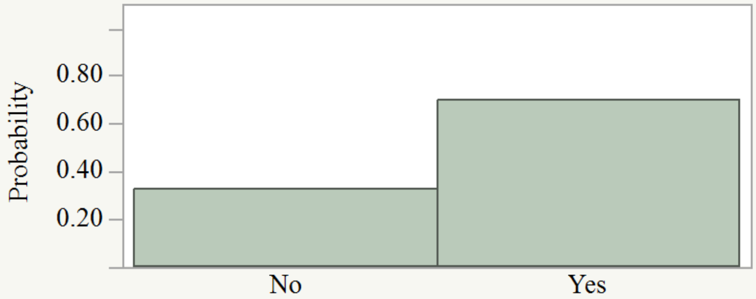
Frequencies

Level	Count	Prob
Garage (attached to your home or freestanding)	529	0.49072
Driveway (Not Covered)	328	0.30427
On the Street	90	0.08349
Carport (Covered, but not fully enclosed)	80	0.07421
Parking Lot	45	0.04174
Other	6	0.00557
Total	1078	1.00000

N Missing 593
6 Levels

Level of electrical service at home parking location

Home park: 110



Frequencies

Level	Count	Prob
No	526	0.31478
Yes	1145	0.68522
Total	1671	1.00000

N Missing 0
2 Levels

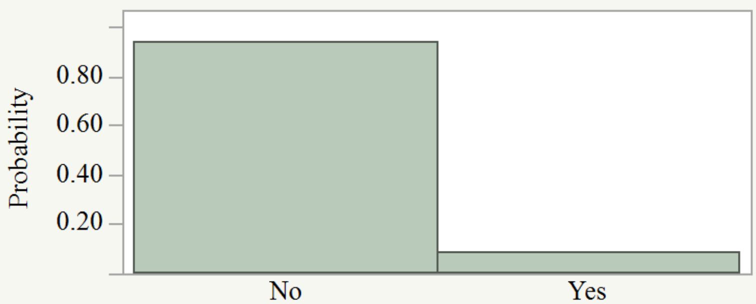
Home Park: 220

Frequencies

Level	Count	Prob
No	1239	0.74147
Yes	432	0.25853
Total	1671	1.00000

N Missing 0
2 Levels

Home park: EVSE

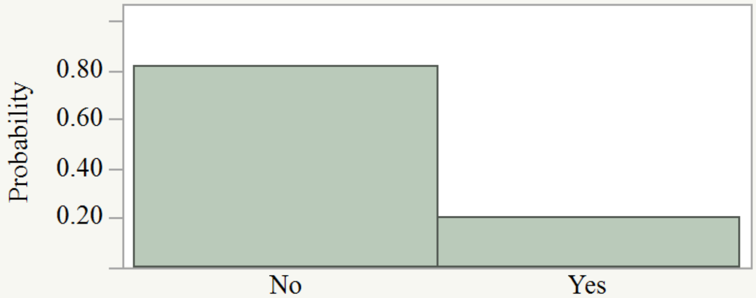


Frequencies

Level	Count	Prob
No	1548	0.92639
Yes	123	0.07361
Total	1671	1.00000

N Missing 0
2 Levels

Home park: none

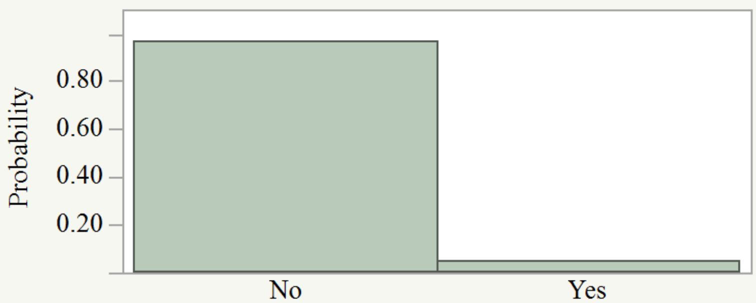


Frequencies

Level	Count	Prob
No	1352	0.80910
Yes	319	0.19090
Total	1671	1.00000

N Missing 0
2 Levels

Home park: don't know



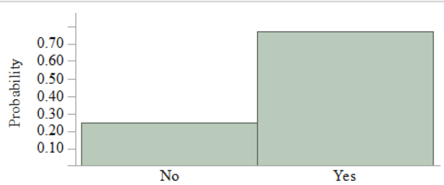
Frequencies

Level	Count	Prob
No	1600	0.95751
Yes	71	0.04249
Total	1671	1.00000

N Missing 0
2 Levels

Only asked if Home park: EVSE = Yes

Home EVSE access

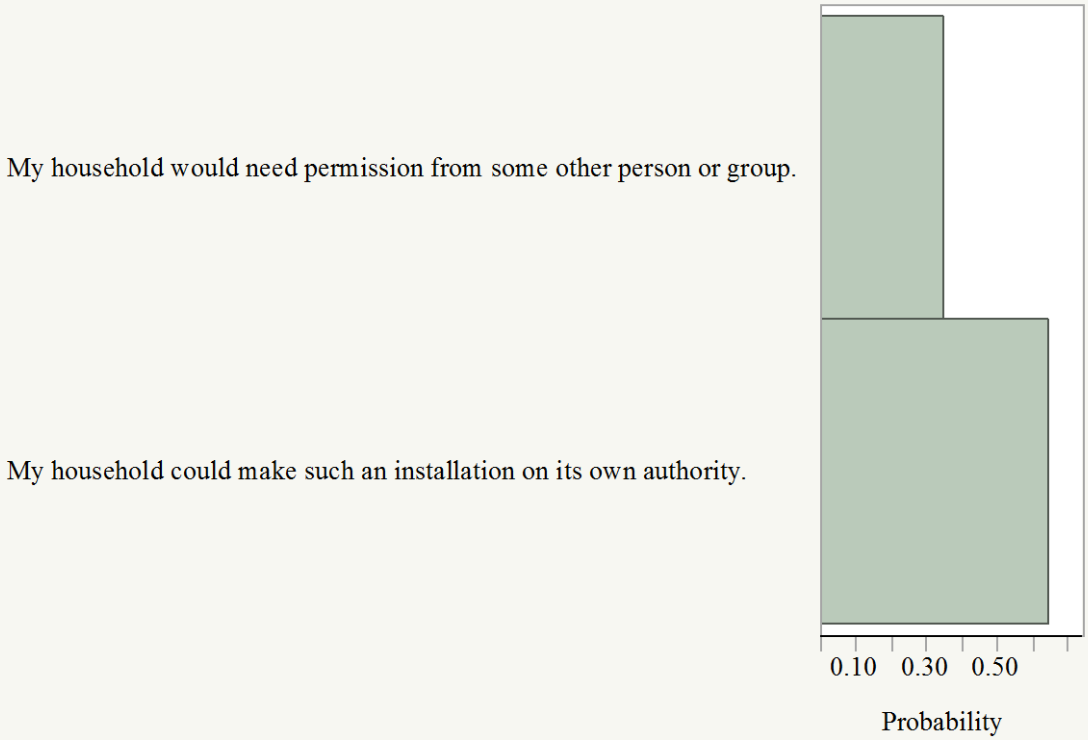


Frequencies

Level	Count	Prob
No	29	0.23577
Yes, it belongs to my household or my household could use it whenever we wanted.	94	0.76423
Total	123	1.00000

N Missing 1548
2 Levels

Electricy install authority

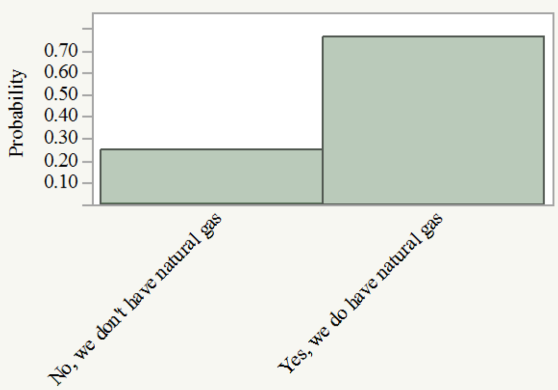


Frequencies

Level	Count	Prob
My household could make such an installation on its own authority.	1083	0.64811
My household would need permission from some other person or group.	588	0.35189
Total	1671	1.00000

N Missing 0
2 Levels

Home natural gas



Frequencies

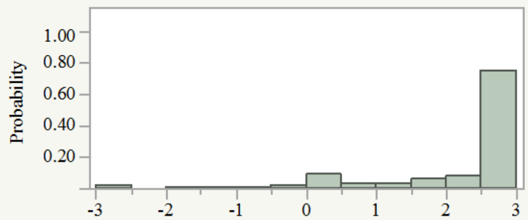
Level	Count	Prob
No, we don't have natural gas	405	0.24237
Yes, we do have natural gas	1266	0.75763
Total	1671	1.00000

N Missing 0
2 Levels

Awareness, Knowledge, and Prior Consideration of PEVs and FCEVS

Familiar with vehicle types, distributions truncated to eliminate non-responses.
-3 = no; 3 = yes.

Familiarity Gasoline Vehicles (trunc)



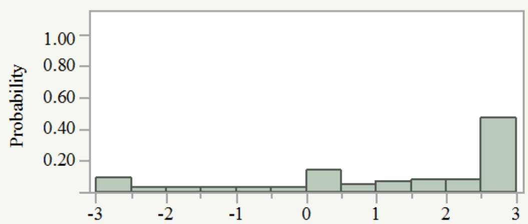
Quantiles

100.0%	maximum	2.99
99.5%		2.99
97.5%		2.97
90.0%		2.93
75.0%	quartile	2.89
50.0%	median	2.82
25.0%	quartile	2.405
10.0%		0.604
2.5%		0
0.5%		-2.8513
0.0%	minimum	-3

Summary Statistics

Mean	2.3651494
Std Dev	1.0086823
Std Err Mean	0.0254326
Upper 95% Mean	2.4150347
Lower 95% Mean	2.3152641
N	1573

Familiarity BEVs (trunc)



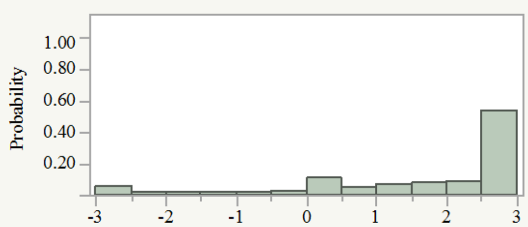
Quantiles

100.0%	maximum	2.99
99.5%		2.98
97.5%		2.96
90.0%		2.92
75.0%	quartile	2.86
50.0%	median	2.16
25.0%	quartile	0
10.0%		-1.848
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	1.3504411
Std Dev	1.8486523
Std Err Mean	0.04971
Upper 95% Mean	1.4479564
Lower 95% Mean	1.2529258
N	1383

Familiarity HEVs (trunc)



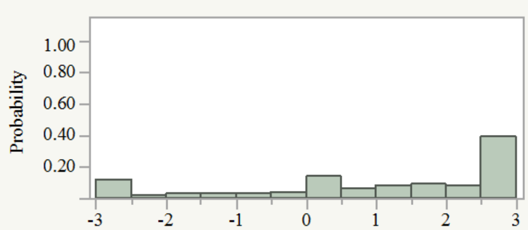
Quantiles

100.0%	maximum	2.99
99.5%		2.99
97.5%		2.96
90.0%		2.92
75.0%	quartile	2.87
50.0%	median	2.64
25.0%	quartile	0.95
10.0%		-0.378
2.5%		-2.9645
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	1.7020619
Std Dev	1.6374784
Std Err Mean	0.0434389
Upper 95% Mean	1.7872732
Lower 95% Mean	1.6168507
N	1421

Familiarity PHEVs (trunc)



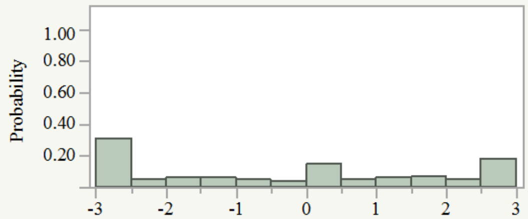
Quantiles

100.0%	maximum	2.99
99.5%		2.97545
97.5%		2.95
90.0%		2.91
75.0%	quartile	2.83
50.0%	median	1.665
25.0%	quartile	0
10.0%		-2.666
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	1.0718837
Std Dev	1.9575093
Std Err Mean	0.0545016
Upper 95% Mean	1.1788052
Lower 95% Mean	0.9649622
N	1290

Familiarity FCEVs (trunc)



Quantiles

100.0%	maximum	2.99
99.5%		2.97
97.5%		2.92
90.0%		2.82
75.0%	quartile	1.57
50.0%	median	-0.19
25.0%	quartile	-2.8
10.0%		-3
2.5%		-3
0.5%		-3
0.0%	minimum	-3

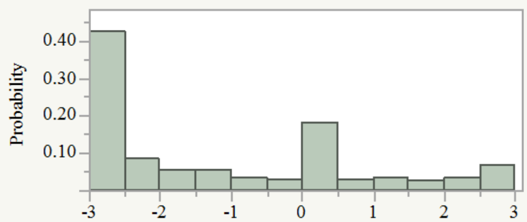
Summary Statistics

Mean	-0.369815
Std Dev	2.1530525
Std Err Mean	0.0671845
Upper 95% Mean	-0.23798
Lower 95% Mean	-0.50165
N	1027

Comparative environmental risk of gasoline and electricity in the respondent's region. Distribution truncated to eliminate non-responses.

-3 = electricity is less of a risk; 3 = gasoline is less of a risk.

Environmental Risk (trunc)



Quantiles

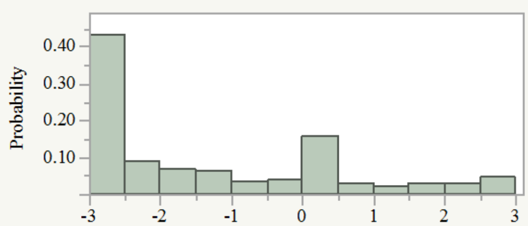
100.0%	maximum	2.96
99.5%		2.95
97.5%		2.89
90.0%		1.85
75.0%	quartile	0
50.0%	median	-2.005
25.0%	quartile	-2.91
10.0%		-3
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	-1.24203
Std Dev	1.8597466
Std Err Mean	0.0506159
Upper 95% Mean	-1.142735
Lower 95% Mean	-1.341324
N	1350

Comparative risk to human health. -3 = electricity is less of a risk; 3 = gasoline is less of a risk.

Health Risk (trunc)



Quantiles

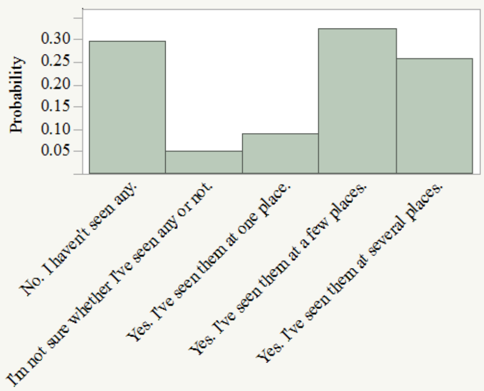
100.0%	maximum	2.98
99.5%		2.93
97.5%		2.86
90.0%		1.346
75.0%	quartile	0
50.0%	median	-2.16
25.0%	quartile	-2.92
10.0%		-3
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	-1.391086
Std Dev	1.7499153
Std Err Mean	0.0484038
Upper 95% Mean	-1.296129
Lower 95% Mean	-1.486044
N	1307

Seen PEV charging in the (non-residential) parking facilities they use

Seen Public EVSEs



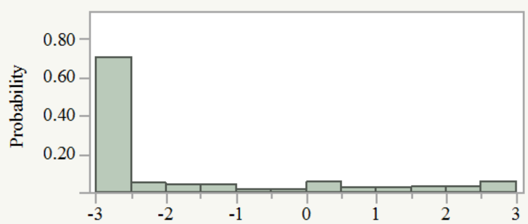
Frequencies

Level	Count	Prob
No. I haven't seen any.	486	0.29084
I'm not sure whether I've seen any or not.	78	0.04668
Yes. I've seen them at one place.	147	0.08797
Yes. I've seen them at a few places.	535	0.32017
Yes. I've seen them at several places.	425	0.25434
Total	1671	1.00000

N Missing 0
5 Levels

How much driving experience the respondent has in BEVs, HEVs, PHEVs, and FCEVs. Distribution truncated to eliminate non-responses. -3= none at all; 3= extensive driving experience

Driving exp: BEV (trunc)



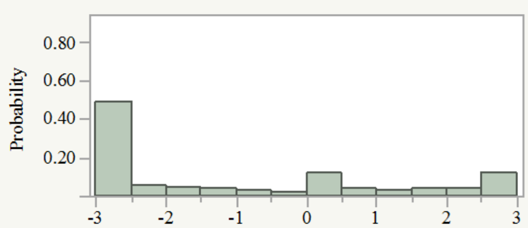
Quantiles

100.0%	maximum	2.99
99.5%		2.94
97.5%		2.85775
90.0%		1.311
75.0%	quartile	-1.765
50.0%	median	-2.9
25.0%	quartile	-3
10.0%		-3
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	-1.967927
Std Dev	1.7406589
Std Err Mean	0.0439583
Upper 95% Mean	-1.881704
Lower 95% Mean	-2.054151
N	1568

Driving exp: HEV (trunc)



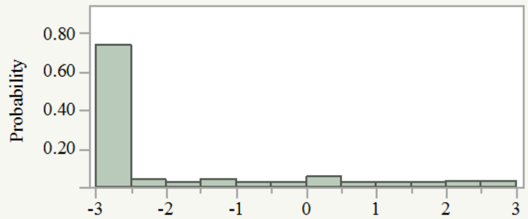
Quantiles

100.0%	maximum	2.99
99.5%		2.96
97.5%		2.92
90.0%		2.67
75.0%	quartile	0.3
50.0%	median	-2.37
25.0%	quartile	-2.96
10.0%		-3
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	-1.147058
Std Dev	2.1234236
Std Err Mean	0.0535222
Upper 95% Mean	-1.042076
Lower 95% Mean	-1.252041
N	1574

Driving exp: PHEV (trunc)



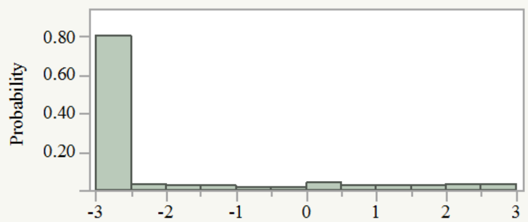
Quantiles

100.0%	maximum	2.98
99.5%		2.95
97.5%		2.68
90.0%		0.74
75.0%	quartile	-2.255
50.0%	median	-2.92
25.0%	quartile	-3
10.0%		-3
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	-2.095236
Std Dev	1.6171902
Std Err Mean	0.0410899
Upper 95% Mean	-2.014638
Lower 95% Mean	-2.175833
N	1549

Driving exp: FCEV (trunc)



Quantiles

100.0%	maximum	2.98
99.5%		2.913
97.5%		2.475
90.0%		0.22
75.0%	quartile	-2.73
50.0%	median	-2.93
25.0%	quartile	-3
10.0%		-3
2.5%		-3
0.5%		-3
0.0%	minimum	-3

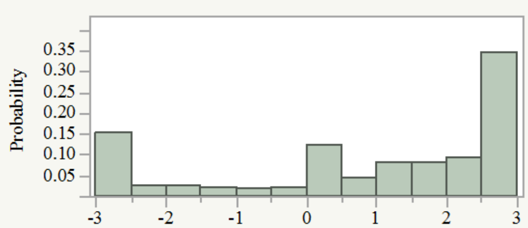
Summary Statistics

Mean	-2.282333
Std Dev	1.5087521
Std Err Mean	0.0384591
Upper 95% Mean	-2.206895
Lower 95% Mean	-2.35777
N	1539

Respondent evaluations of PEVs. Distribution truncated to eliminate non-responses. -3= strongly disagree; 3= strongly agree

Able to plug in a vehicle to charge at home.

BEV: home charge (trunc)



Quantiles

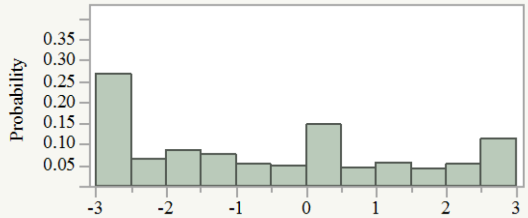
100.0%	maximum	2.99
99.5%		2.98
97.5%		2.94
90.0%		2.89
75.0%	quartile	2.76
50.0%	median	1.555
25.0%	quartile	0
10.0%		-2.895
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	0.8748671
Std Dev	2.0795918
Std Err Mean	0.0565157
Upper 95% Mean	0.9857349
Lower 95% Mean	0.7639992
N	1354

There are enough places (other than home) to charge electric vehicles.

BEV: public charging (trunc)

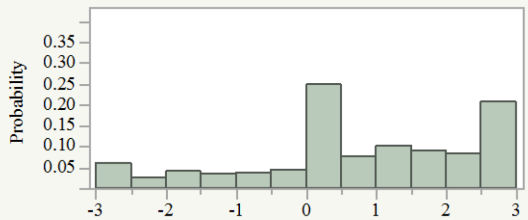


Quantiles		
100.0%	maximum	2.99
99.5%		2.96235
97.5%		2.9
90.0%		2.577
75.0%	quartile	0.9475
50.0%	median	-0.75
25.0%	quartile	-2.62
10.0%		-2.98
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics	
Mean	-0.59497
Std Dev	1.970314
Std Err Mean	0.0535855
Upper 95% Mean	-0.489851
Lower 95% Mean	-0.70009
N	1352

It takes too long to charge a BEV.

BEV: charge time (trunc)

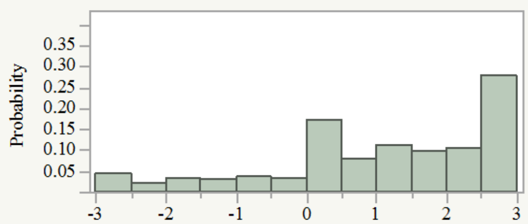


Quantiles		
100.0%	maximum	2.99
99.5%		2.98
97.5%		2.92
90.0%		2.85
75.0%	quartile	2.175
50.0%	median	0.735
25.0%	quartile	0
10.0%		-1.7
2.5%		-2.96
0.5%		-3
0.0%	minimum	-3

Summary Statistics	
Mean	0.7282228
Std Dev	1.6385365
Std Err Mean	0.0497212
Upper 95% Mean	0.8257833
Lower 95% Mean	0.6306623
N	1086

Electric vehicles do not travel far enough before needing to be charged.

BEV: range (trunc)

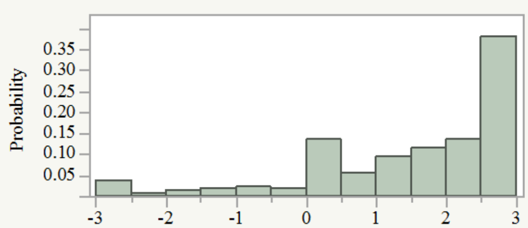


Quantiles		
100.0%	maximum	2.99
99.5%		2.99
97.5%		2.95225
90.0%		2.88
75.0%	quartile	2.6225
50.0%	median	1.38
25.0%	quartile	0
10.0%		-1.333
2.5%		-2.93225
0.5%		-3
0.0%	minimum	-3

Summary Statistics	
Mean	1.1033821
Std Dev	1.6144135
Std Err Mean	0.0460323
Upper 95% Mean	1.1936926
Lower 95% Mean	1.0130716
N	1230

BEVs cost more than gasoline vehicles.

BEV: purchase price (trunc)

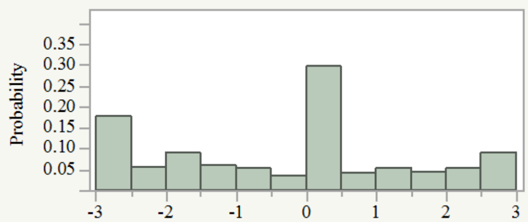


Quantiles		
100.0%	maximum	2.99
99.5%		2.98
97.5%		2.95
90.0%		2.9
75.0%	quartile	2.8
50.0%	median	2.04
25.0%	quartile	0.7
10.0%		-0.136
2.5%		-2.87
0.5%		-3
0.0%	minimum	-3

Summary Statistics	
Mean	1.5597851
Std Dev	1.4650098
Std Err Mean	0.0405853
Upper 95% Mean	1.6394048
Lower 95% Mean	1.4801655
N	1303

Gasoline powered cars are safer than BEVs.

BEV: safety (trunc)

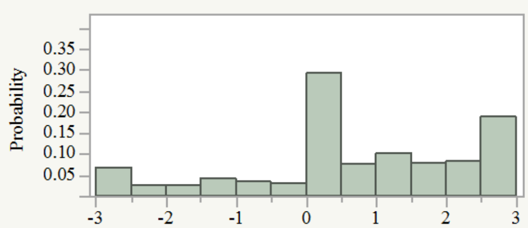


Quantiles		
100.0%	maximum	2.99
99.5%		2.97
97.5%		2.89
90.0%		2.38
75.0%	quartile	0.6475
50.0%	median	0
25.0%	quartile	-1.8
10.0%		-2.92
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics	
Mean	-0.35403
Std Dev	1.7667329
Std Err Mean	0.0522346
Upper 95% Mean	-0.251543
Lower 95% Mean	-0.456516
N	1144

Gasoline powered cars are more reliable than BEVs.

BEV: reliability (trunc)



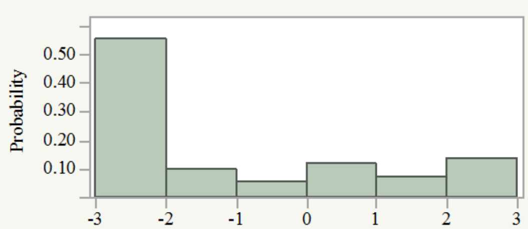
Quantiles		
100.0%	maximum	2.99
99.5%		2.96
97.5%		2.92
90.0%		2.83
75.0%	quartile	2.06
50.0%	median	0.53
25.0%	quartile	0
10.0%		-1.66
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics	
Mean	0.6657864
Std Dev	1.6261136
Std Err Mean	0.0471585
Upper 95% Mean	0.7583096
Lower 95% Mean	0.5732632
N	1189

Respondent evaluations of PEVs. Distribution truncated to eliminate non-responses. -3= strongly disagree; 3= strongly agree

There are enough hydrogen fueling stations.

FCEV: public refueling (trunc)

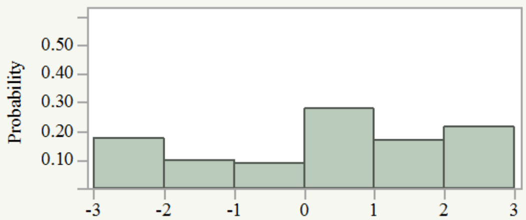


Quantiles		
100.0%	maximum	2.99
99.5%		2.97
97.5%		2.9
90.0%		2.38
75.0%	quartile	0.195
50.0%	median	-2.32
25.0%	quartile	-2.93
10.0%		-3
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics	
Mean	-1.240104
Std Dev	2.0369451
Std Err Mean	0.0658451
Upper 95% Mean	-1.110887
Lower 95% Mean	-1.369322
N	957

FCEVs take too long to refuel.

FCEV: fueling time (trunc)



Quantiles

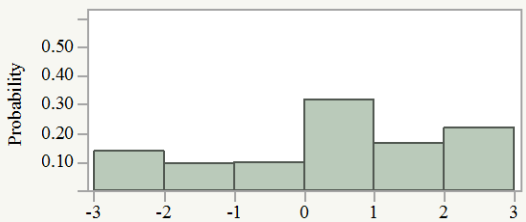
100.0%	maximum	2.99
99.5%		2.9592
97.5%		2.893
90.0%		2.646
75.0%	quartile	1.755
50.0%	median	0.13
25.0%	quartile	-1.205
10.0%		-2.74
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	0.2092043
Std Dev	1.813711
Std Err Mean	0.0771268
Upper 95% Mean	0.3607023
Lower 95% Mean	0.0577063
N	553

FCEVs don't travel far enough without needing to be refueled.

FCEV: reliabilty (trunc)



Quantiles

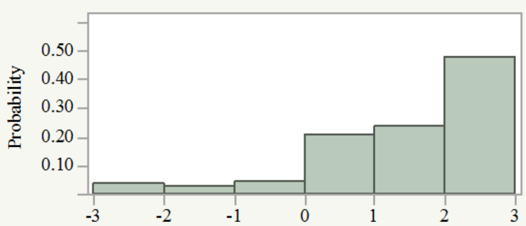
100.0%	maximum	2.99
99.5%		2.98
97.5%		2.91475
90.0%		2.74
75.0%	quartile	1.79
50.0%	median	0.14
25.0%	quartile	-0.6525
10.0%		-2.528
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	0.3323103
Std Dev	1.7326928
Std Err Mean	0.0719462
Upper 95% Mean	0.4736176
Lower 95% Mean	0.1910031
N	580

FCEVs cost more than gasoline cars.

FCEV: purchase price (trunc)



Quantiles

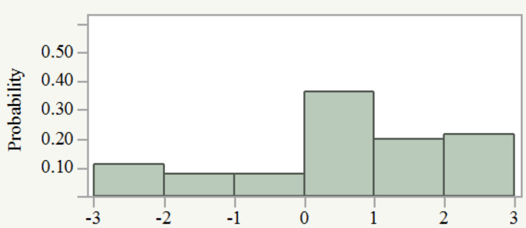
100.0%	maximum	2.99
99.5%		2.99
97.5%		2.94
90.0%		2.89
75.0%	quartile	2.765
50.0%	median	1.86
25.0%	quartile	0.71
10.0%		0
2.5%		-2.5145
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	1.5447736
Std Dev	1.377546
Std Err Mean	0.0495469
Upper 95% Mean	1.6420362
Lower 95% Mean	1.447511
N	773

Gasoline vehicles are safer than FCEVs.

FCEV: safety (trunc)



Quantiles

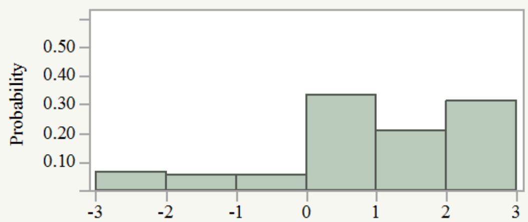
100.0%	maximum	2.98
99.5%		2.97
97.5%		2.93
90.0%		2.786
75.0%	quartile	1.725
50.0%	median	0.27
25.0%	quartile	0
10.0%		-2.033
2.5%		-2.9865
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	0.485496
Std Dev	1.6261437
Std Err Mean	0.0595373
Upper 95% Mean	0.6023769
Lower 95% Mean	0.368615
N	746

Gasoline vehicles are more reliable than FCEVs.

FCEV: reliabilty (trunc) 2



Quantiles

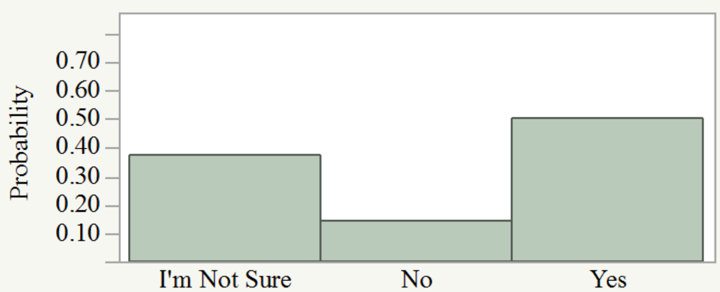
100.0%	maximum	2.98
99.5%		2.97
97.5%		2.948
90.0%		2.87
75.0%	quartile	2.34
50.0%	median	1.05
25.0%	quartile	0
10.0%		-1.122
2.5%		-2.948
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	0.9391656
Std Dev	1.5567071
Std Err Mean	0.0562094
Upper 95% Mean	1.0495084
Lower 95% Mean	0.8288228
N	767

Awareness of incentives for alternatives to gasoline and diesel.

Incentives: Federal



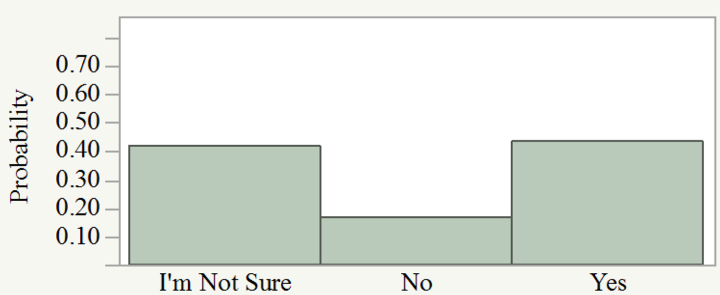
Frequencies

Level	Count	Prob
I'm Not Sure	611	0.36587
No	234	0.14012
Yes	825	0.49401
Total	1670	1.00000

N Missing 1
3 Levels

Awareness of “state” incentives refers to any state, i.e., has the respondent heard that any state or states are offering incentives.

Incentives: State



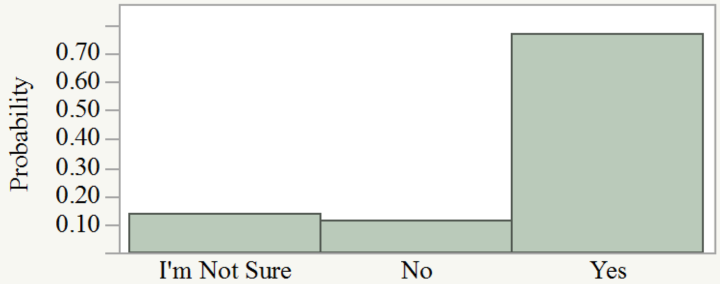
Frequencies

Level	Count	Prob
I'm Not Sure	682	0.40863
No	272	0.16297
Yes	715	0.42840
Total	1669	1.00000

N Missing 2
3 Levels

Asked only if respondent says “Yes” they have heard that states are offering incentives. For the subset of respondents analyzed in this report “My state” is California.

Incentives: My state



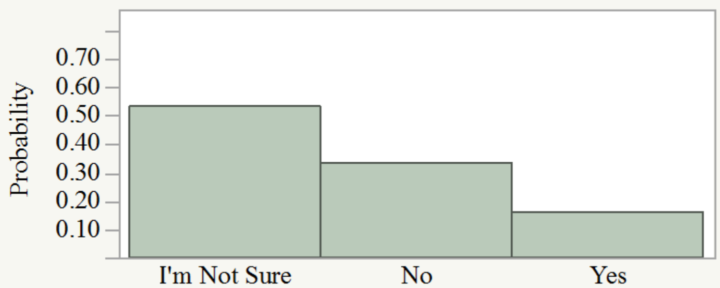
Frequencies

Level	Count	Prob
I'm Not Sure	94	0.13147
No	77	0.10769
Yes	544	0.76084
Total	715	1.00000

N Missing 956
3 Levels

The same logic applies to cities as to states. The first question asks if the respondent has heard of incentives offered by any city. The follow-up question is only asked if they respond, “Yes.” The second question then asks if they have heard their city offers incentives.

Incentives: Cities

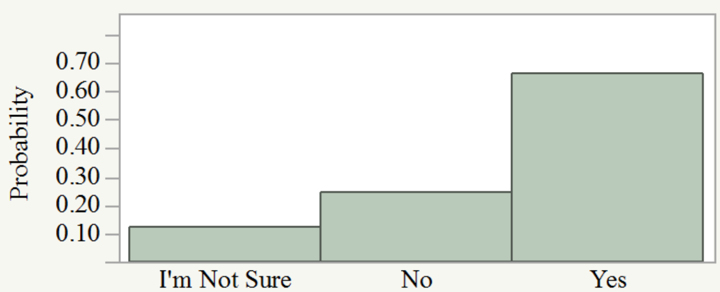


Frequencies

Level	Count	Prob
I'm Not Sure	871	0.52156
No	542	0.32455
Yes	257	0.15389
Total	1670	1.00000

N Missing 1
3 Levels

Incentives: My city

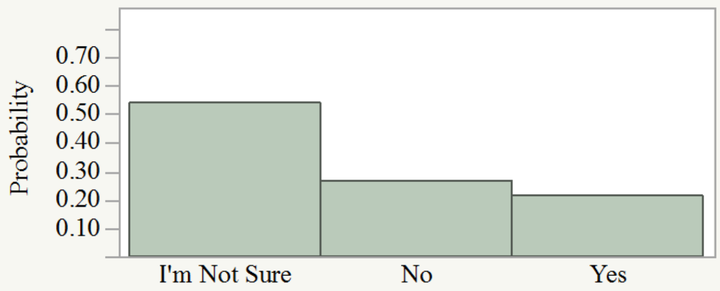


Frequencies

Level	Count	Prob
I'm Not Sure	29	0.11284
No	60	0.23346
Yes	168	0.65370
Total	257	1.00000

N Missing 1414
3 Levels

Incentives: AQMDs



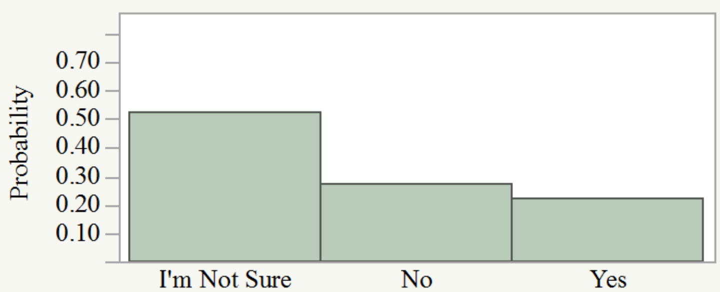
Frequencies

Level	Count	Prob
I'm Not Sure	889	0.53234
No	434	0.25988
Yes	347	0.20778
Total	1670	1.00000

N Missing 1
3 Levels

The same logic applies to utilities as to cities and states. See notes above.

Incentives: Electric utilities

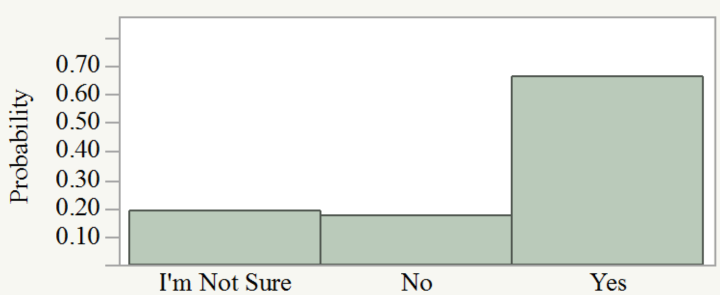


Frequencies

Level	Count	Prob
I'm Not Sure	864	0.51737
No	448	0.26826
Yes	358	0.21437
Total	1670	1.00000

N Missing 1
3 Levels

Incentives: My utility

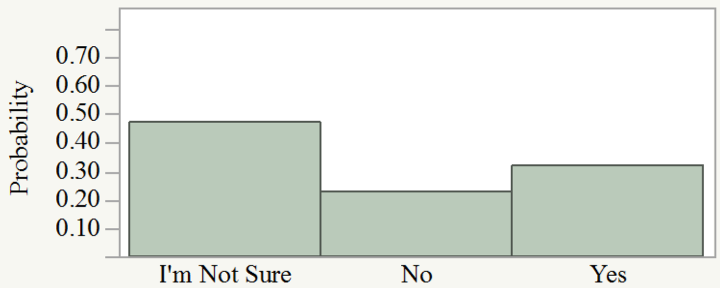


Frequencies

Level	Count	Prob
I'm Not Sure	66	0.18436
No	59	0.16480
Yes	233	0.65084
Total	358	1.00000

N Missing 1313
3 Levels

Incentives: Veh Makers

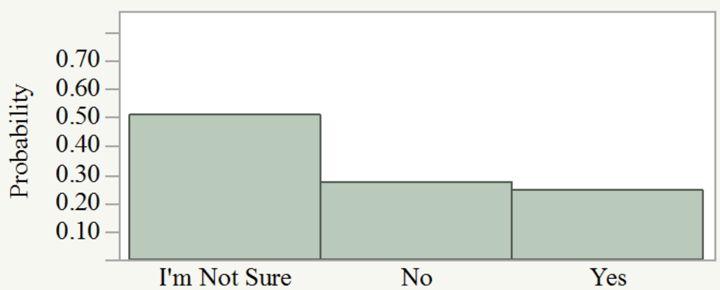


Frequencies

Level	Count	Prob
I'm Not Sure	778	0.46587
No	373	0.22335
Yes	519	0.31078
Total	1670	1.00000

N Missing 1
3 Levels

Incentives: Veh dealers

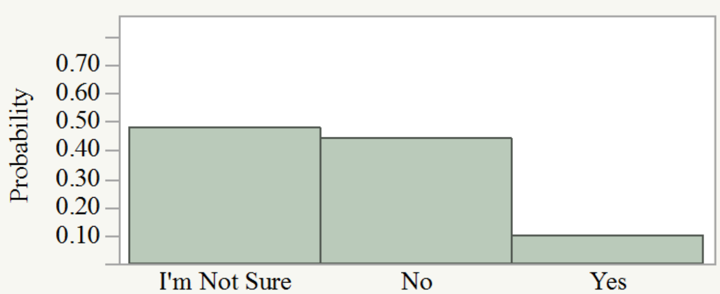


Frequencies

Level	Count	Prob
I'm Not Sure	834	0.49940
No	445	0.26647
Yes	391	0.23413
Total	1670	1.00000

N Missing 1
3 Levels

Incentives: Oil companies

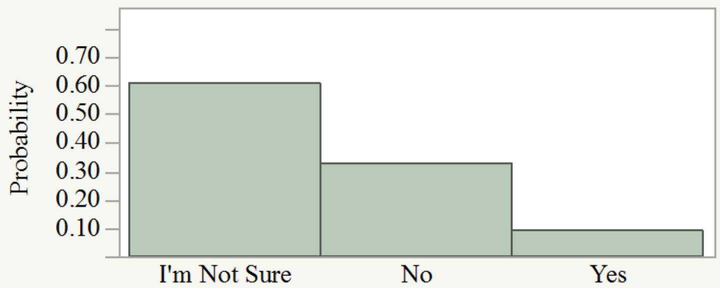


Frequencies

Level	Count	Prob
I'm Not Sure	791	0.47365
No	727	0.43533
Yes	152	0.09102
Total	1670	1.00000

N Missing 1
3 Levels

Incentives: Other businesses

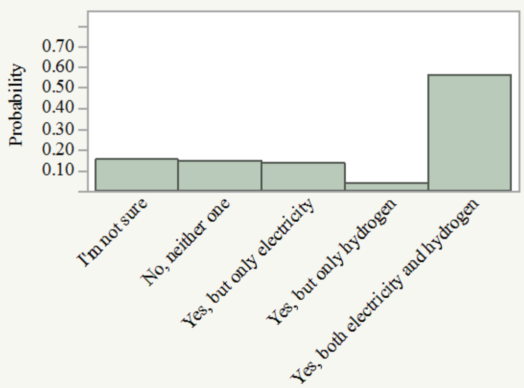


Frequencies

Level	Count	Prob
I'm Not Sure	1001	0.60012
No	531	0.31835
Yes	136	0.08153
Total	1668	1.00000

N Missing 3
3 Levels

Should government offer incentives



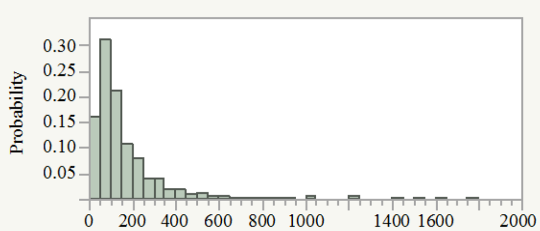
Frequencies

Level	Count	Prob
I'm not sure	246	0.14722
No, neither one	223	0.13345
Yes, but only electricity	218	0.13046
Yes, but only hydrogen	53	0.03172
Yes, both electricity and hydrogen	931	0.55715
Total	1671	1.00000

N Missing 0
5 Levels

Amount of last electricity bill. Distribution truncated to eliminate non-responses.

Last electricity bill (trunc)



Quantiles

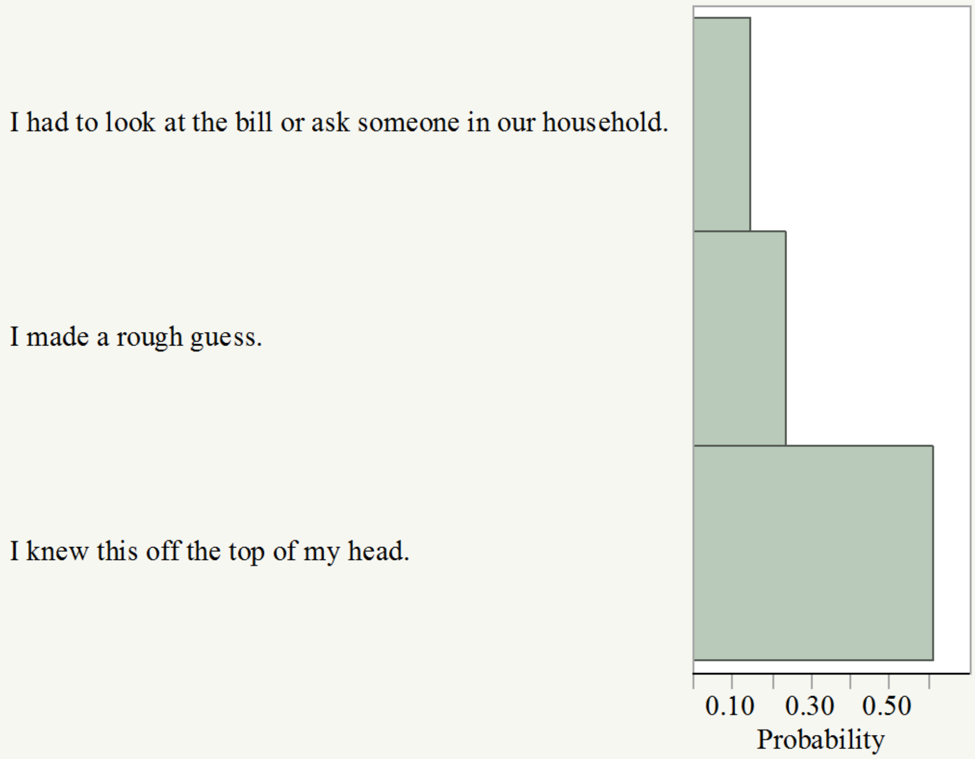
100.0%	maximum	2000
99.5%		1200
97.5%		500
90.0%		300
75.0%	quartile	171
50.0%	median	100
25.0%	quartile	60
10.0%		40
2.5%		20.75
0.5%		1
0.0%	minimum	0

Summary Statistics

Mean	146.44986
Std Dev	166.33773
Std Err Mean	4.3399016
Upper 95% Mean	154.96293
Lower 95% Mean	137.93679
N	1469

65 people do not pay a monthly bill for electricity either because they have solar (which generally requires they settle their account with their electric utility annually) or because it is included in their rent.

Electricity bill accuracy



Frequencies

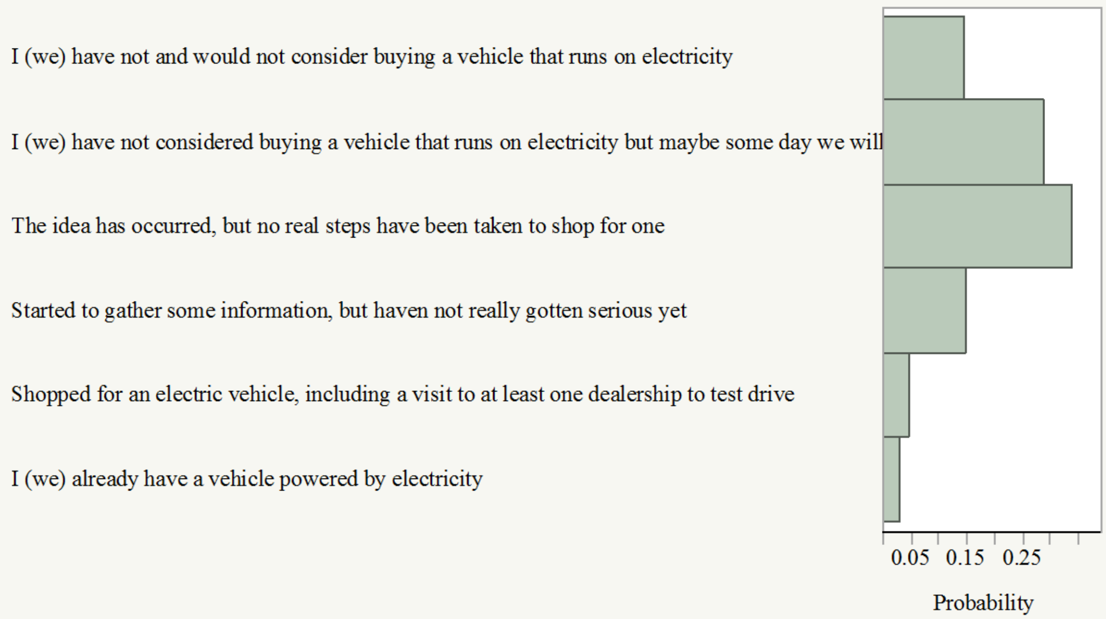
Level	Count	Prob
I knew this off the top of my head.	1028	0.61520
I made a rough guess.	399	0.23878
I had to look at the bill or ask someone in our household.	244	0.14602
Total	1671	1.00000

N Missing 0

3 Levels

Has household already considered acquiring a vehicle powered by electricity.

Consider a BEV



Frequencies

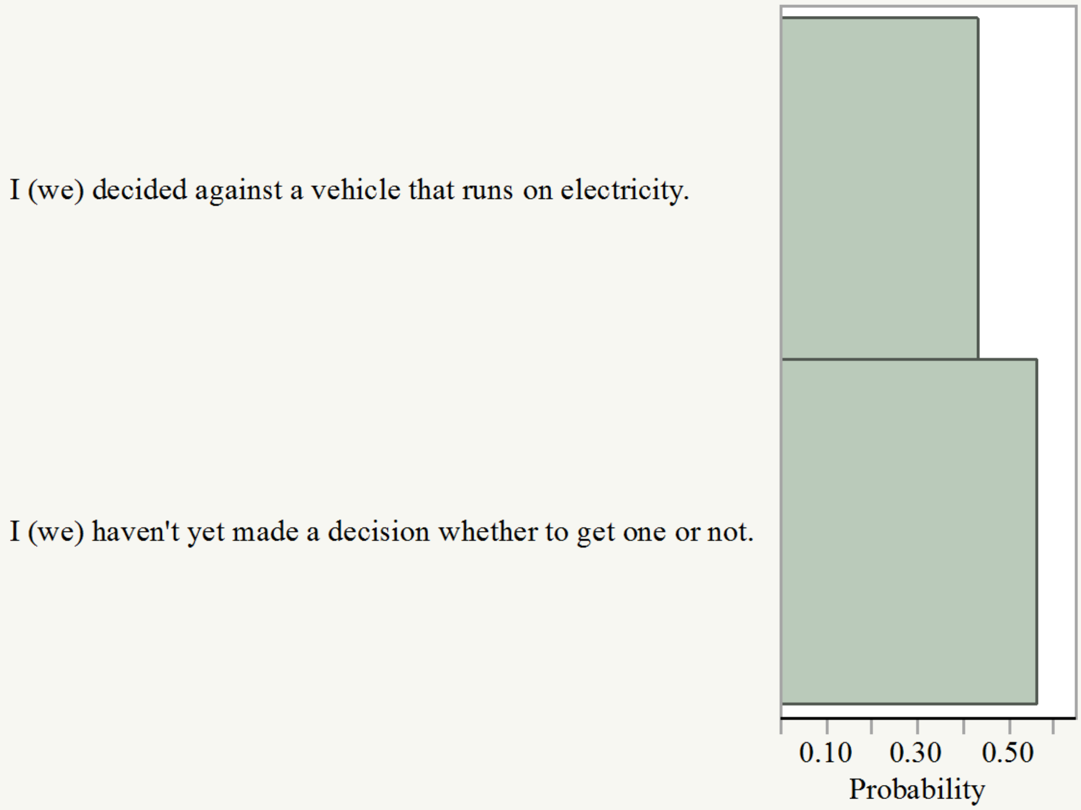
Level	Count	Prob
I (we) already have a vehicle powered by electricity	51	0.03052
Shopped for an electric vehicle, including a visit to at least one dealership to test drive	78	0.04668
Started to gather some information, but haven not really gotten serious yet	249	0.14901
The idea has occurred, but no real steps have been taken to shop for one	568	0.33992
I (we) have not considered buying a vehicle that runs on electricity but maybe some day we will	480	0.28725
I (we) have not and would not consider buying a vehicle that runs on electricity	245	0.14662
Total	1671	1.00000

N Missing 0

6 Levels

Asked only if household has “shopped for an electric vehicle, including a visit to at last one dealership to test drive.

Decision BEV



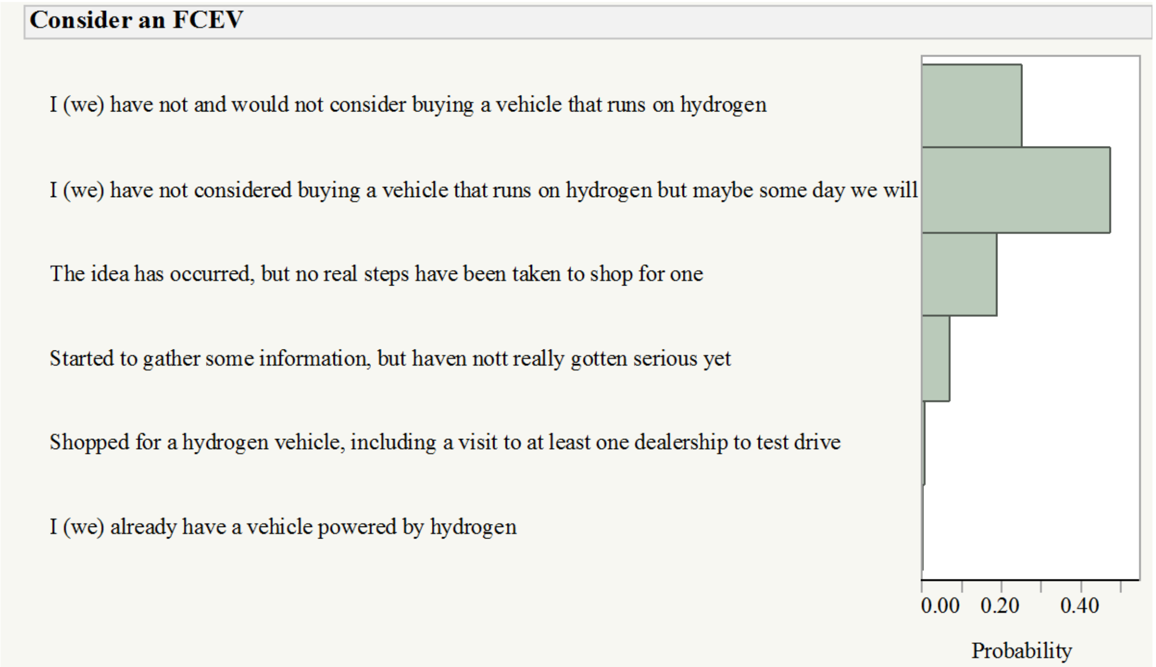
Frequencies

Level	Count	Prob
I (we) haven't yet made a decision whether to get one or not.	44	0.56410
I (we) decided against a vehicle that runs on electricity.	34	0.43590
Total	78	1.00000

N Missing 1593

2 Levels

Has household already considered acquiring a vehicle powered by hydrogen.



Frequencies

Level	Count	Prob
I (we) already have a vehicle powered by hydrogen	8	0.00479
Shopped for a hydrogen vehicle, including a visit to at least one dealership to test drive	16	0.00958
Started to gather some information, but haven nott really gotten serious yet	117	0.07002
The idea has occurred, but no real steps have been taken to shop for one	316	0.18911
I (we) have not considered buying a vehicle that runs on hydrogen but maybe some day we will	793	0.47457
I (we) have not and would not consider buying a vehicle that runs on hydrogen	421	0.25194
Total	1671	1.00000

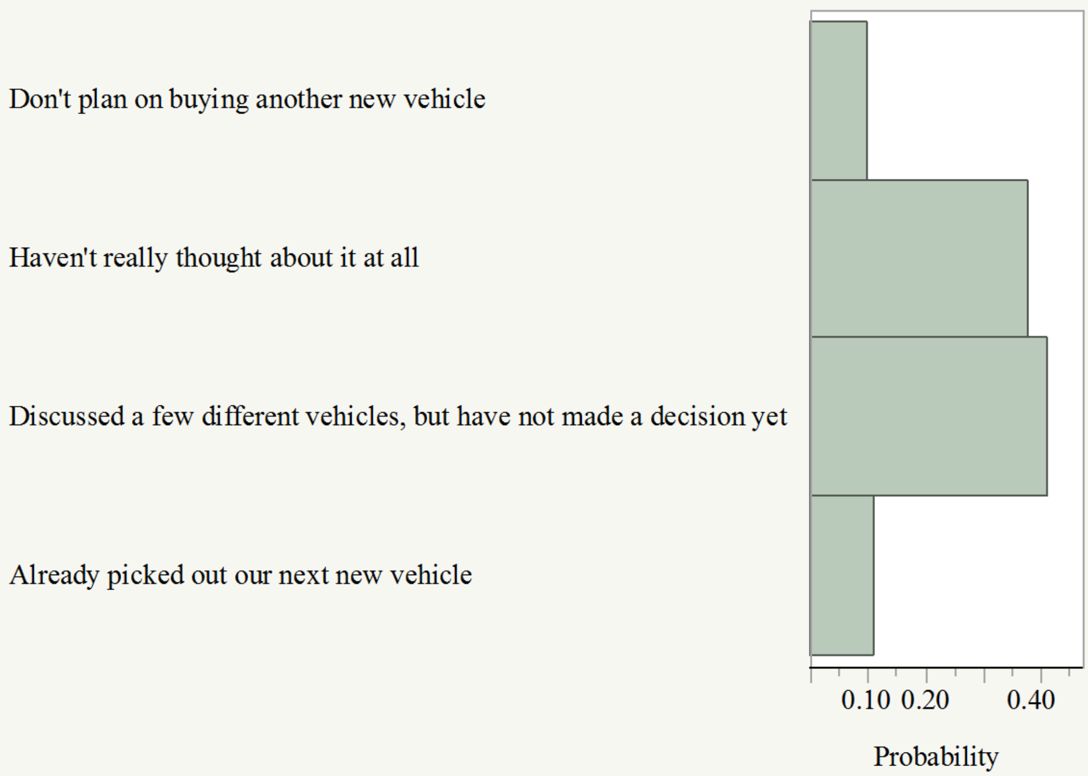
N Missing 0
6 Levels

Of the 16 participants who say they've shopped for a vehicle that runs on hydrogen, nine decided against and seven haven't yet made a decision whether to get one or not. Of the nine who decided against, one did so because there was no discount and another because the vehicle they wanted wasn't in stock. Another person said "Toyota" and one said "Honda," perhaps indicating they did not want a vehicle from those manufacturers.

Vehicle Design Games

Series of questions that establishes the starting vehicle for the vehicle design games that follow.

New vehicle intent



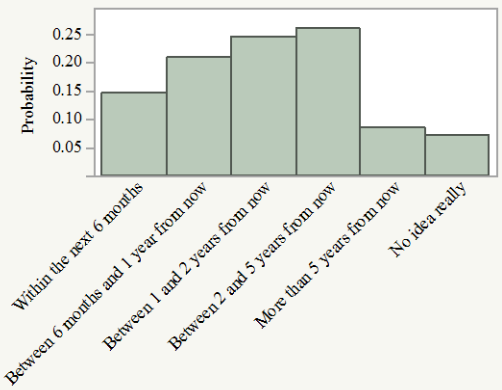
Frequencies

Level	Count	Prob
Already picked out our next new vehicle	186	0.11131
Discussed a few different vehicles, but have not made a decision yet	687	0.41113
Haven't really thought about it at all	635	0.38001
Don't plan on buying another new vehicle	163	0.09755
Total	1671	1.00000

N Missing 0
4 Levels

Respondents who do not plan on buying another new vehicle are given the option to start with their most recently acquired new vehicle.

New vehicle timing

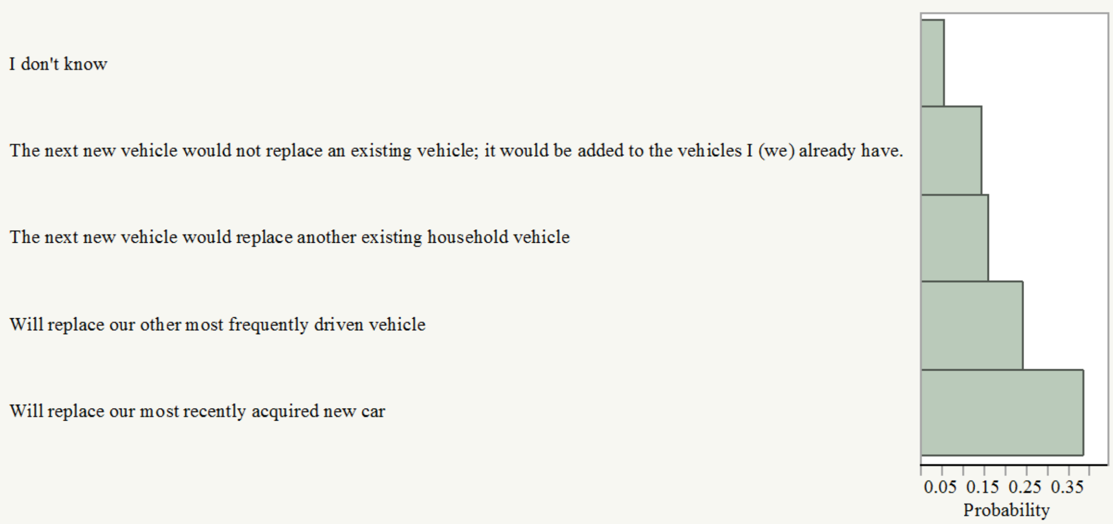


Frequencies

Level	Count	Prob
Within the next 6 months	215	0.14257
Between 6 months and 1 year from now	311	0.20623
Between 1 and 2 years from now	364	0.24138
Between 2 and 5 years from now	387	0.25663
More than 5 years from now	125	0.08289
No idea really	106	0.07029
Total	1508	1.00000

N Missing 163
6 Levels

Additional or replacement

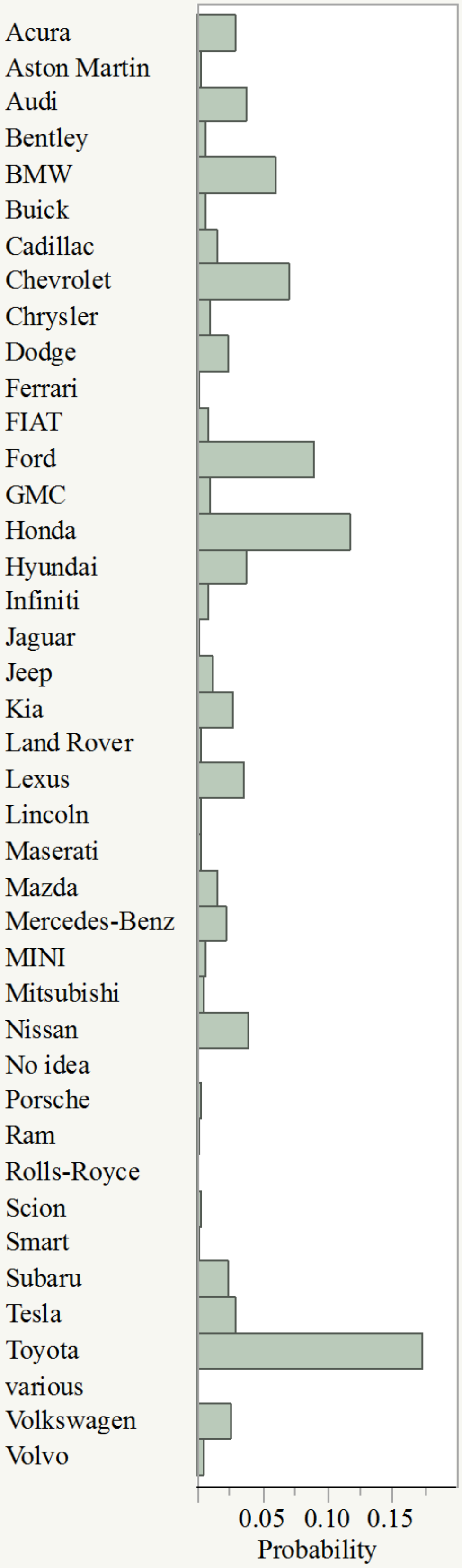


Frequencies

Level	Count	Prob
Will replace our most recently acquired new car	583	0.38660
Will replace our other most frequently driven vehicle	368	0.24403
The next new vehicle would replace another existing household vehicle	244	0.16180
The next new vehicle would not replace an existing vehicle; it would be added to the vehicles I (we) already have.	223	0.14788
I don't know	90	0.05968
Total	1508	1.00000

N Missing 163
5 Levels

Base Make



Frequencies

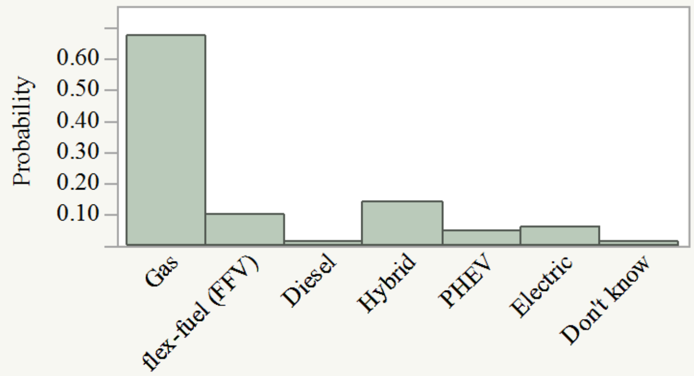
Level	Count	Prob
Acura	50	0.02994
Aston Martin	7	0.00419
Audi	63	0.03772
Bentley	13	0.00778
BMW	101	0.06048
Buick	12	0.00719
Cadillac	26	0.01557
Chevrolet	120	0.07186
Chrysler	16	0.00958
Dodge	42	0.02515
Ferrari	4	0.00240
FIAT	14	0.00838
Ford	150	0.08982
GMC	17	0.01018
Honda	196	0.11737
Hyundai	65	0.03892
Infiniti	15	0.00898
Jaguar	3	0.00180
Jeep	21	0.01257
Kia	47	0.02814
Land Rover	7	0.00419
Lexus	61	0.03653
Lincoln	5	0.00299
Maserati	6	0.00359
Mazda	26	0.01557
Mercedes-Benz	39	0.02335
MINI	11	0.00659
Mitsubishi	8	0.00479
Nissan	68	0.04072
No idea	1	0.00060
Porsche	7	0.00419
Ram	4	0.00240
Rolls-Royce	1	0.00060
Scion	5	0.00299
Smart	3	0.00180
Subaru	41	0.02455
Tesla	50	0.02994
Toyota	290	0.17365
various	1	0.00060
Volkswagen	44	0.02635
Volvo	10	0.00599
Total	1670	1.00000

N Missing 1

41 Levels

Recoded fuel of the base vehicle

rBase Vehicle Fuel



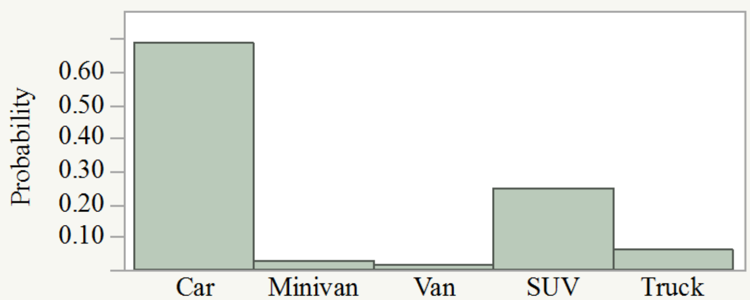
Frequencies

Level	Count	Prob
Gas	1089	0.66484
flex-fuel (FFV)	151	0.09219
Diesel	11	0.00672
Hybrid	219	0.13370
PHEV	69	0.04212
Electric	90	0.05495
Don't know	9	0.00549
Total	1638	1.00000

N Missing 33
7 Levels

Base vehicle body types recoded into reduced number of categories

rBase body type



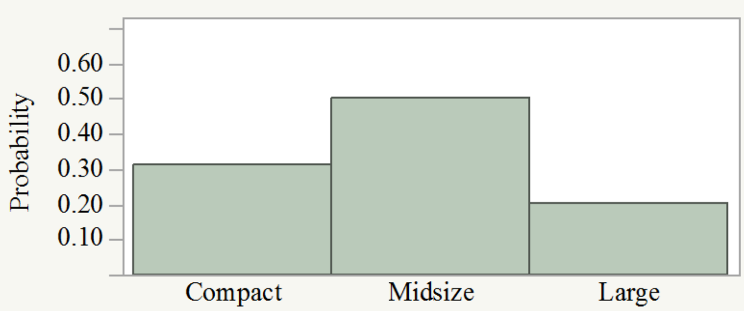
Frequencies

Level	Count	Prob
Car	1130	0.68278
Minivan	31	0.01873
Van	7	0.00423
SUV	395	0.23867
Truck	92	0.05559
Total	1655	1.00000

N Missing 16
5 Levels

Base vehicle body size recoded into reduced number of categories

rBase body size



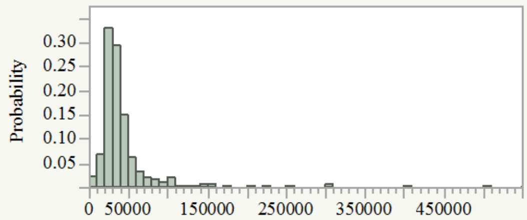
Frequencies

Level	Count	Prob
Compact	507	0.30672
Midsize	818	0.49486
Large	328	0.19843
Total	1653	1.00000

N Missing 18
3 Levels

Recoded expected amount to be paid for next new vehicle. If missing, MSRP is looked up from Edmunds.com

rExpected price



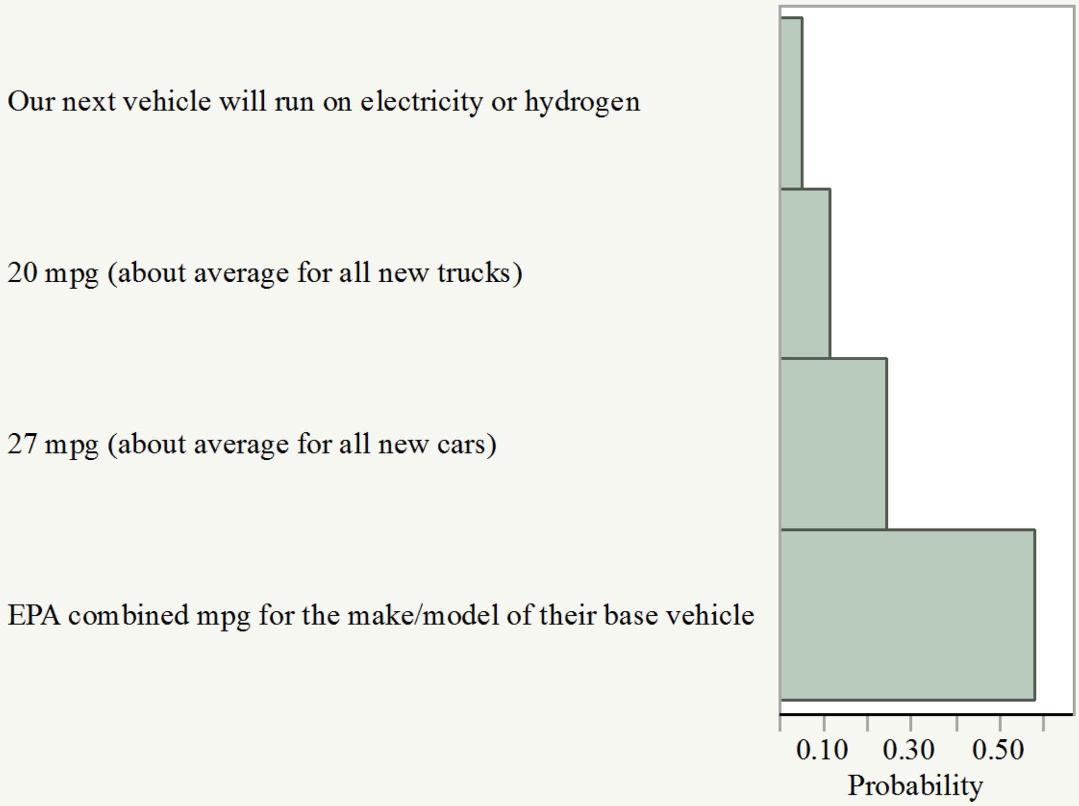
Quantiles

100.0%	maximum	550000
99.5%		300000
97.5%		100000
90.0%		56400
75.0%	quartile	40000
50.0%	median	30000
25.0%	quartile	25000
10.0%		20000
2.5%		10000
0.5%		2582
0.0%	minimum	1200

Summary Statistics

Mean	37394.618
Std Dev	33747.794
Std Err Mean	982.02025
Upper 95% Mean	39321.319
Lower 95% Mean	35467.918
N	1181

Expected fuel economy



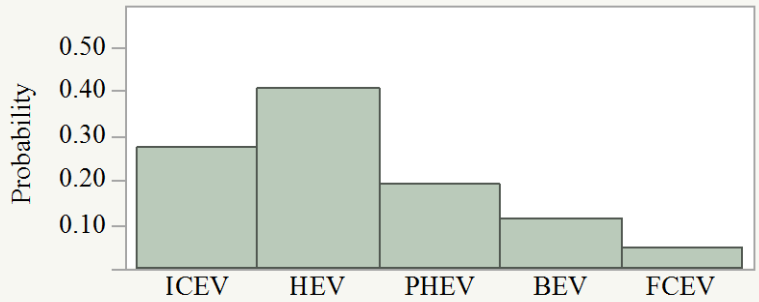
Frequencies

Level	Count	Prob
EPA combined mpg for the make/model of their base vehicle	975	0.58348
27 mpg (about average for all new cars)	413	0.24716
20 mpg (about average for all new trucks)	192	0.11490
Our next vehicle will run on electricity or hydrogen	91	0.05446
Total	1671	1.00000

N Missing 0
4 Levels

Game 1 Results: All vehicles are allowed to have any drivetrain type. No incentives are offered.

Game 1 drivetrain design

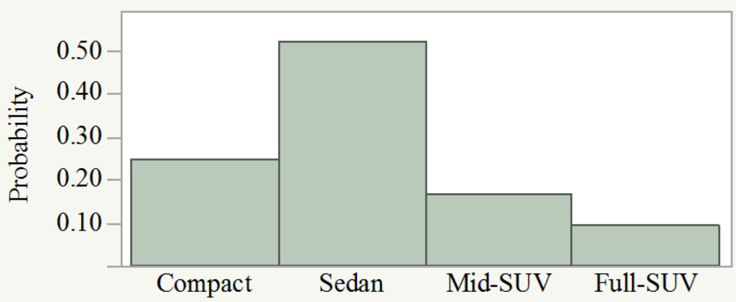


Frequencies

Level	Count	Prob
ICEV	443	0.26543
HEV	670	0.40144
PHEV	312	0.18694
BEV	176	0.10545
FCEV	68	0.04074
Total	1669	1.00000

N Missing 2
5 Levels

Game 1: body style design



Frequencies

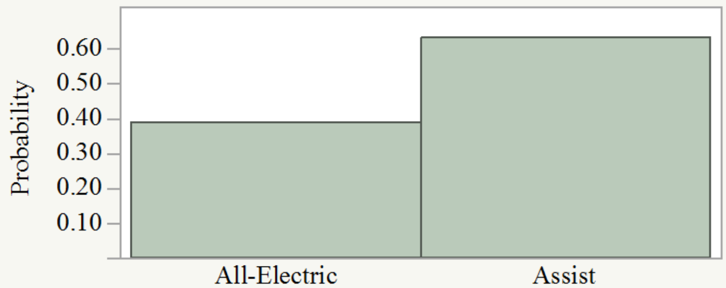
Level	Count	Prob
Compact	401	0.24012
Sedan	858	0.51377
Mid-SUV	268	0.16048
Full-SUV	143	0.08563
Total	1670	1.00000

N Missing 1
4 Levels

Attributes of PHEVs.

Charge-depleting operation

Game 1: PHEV mode



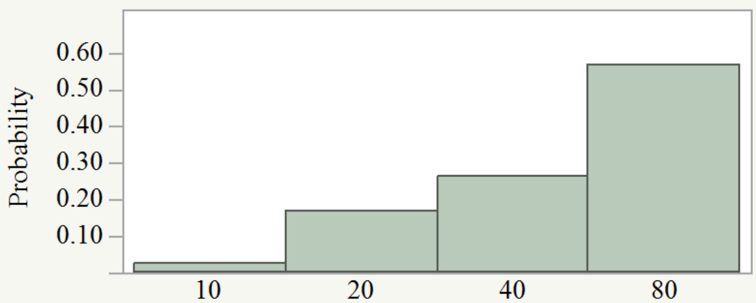
Frequencies

Level	Count	Prob
All-Electric	118	0.37821
Assist	194	0.62179
Total	312	1.00000

N Missing 1359
2 Levels

Charge-depleting range

Game 1: PHEV electric range



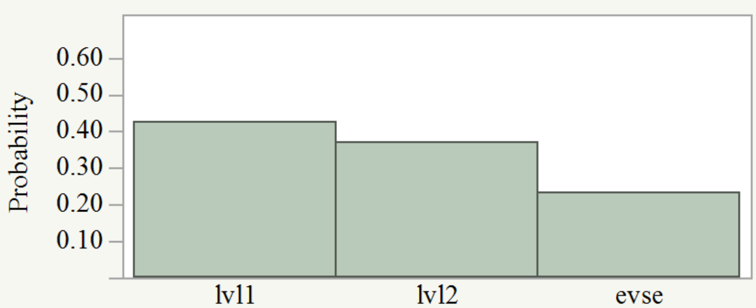
Frequencies

Level	Count	Prob
10	6	0.01923
20	51	0.16346
40	80	0.25641
80	175	0.56090
Total	312	1.00000

N Missing 1359
4 Levels

lvl1 = 1.1 Kw; lvl2 = 3.3Kw; and evse = 6.6Kw

Game 1: PHEV home charge level



Frequencies

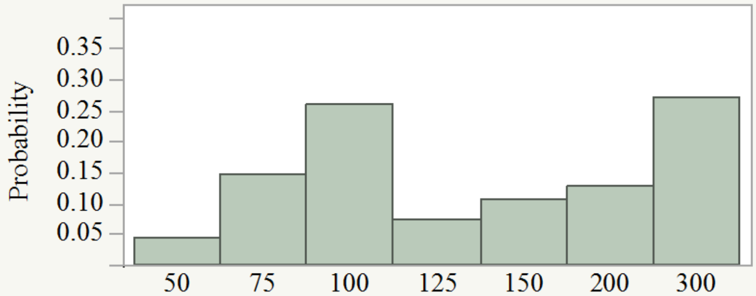
Level	Count	Prob
lvl1	118	0.41404
lvl2	103	0.36140
evse	64	0.22456
Total	285	1.00000

N Missing 1386
3 Levels

135 participants included the quick charge option in their PHEV design.

Attributes of BEVs

Game 1: BEV range

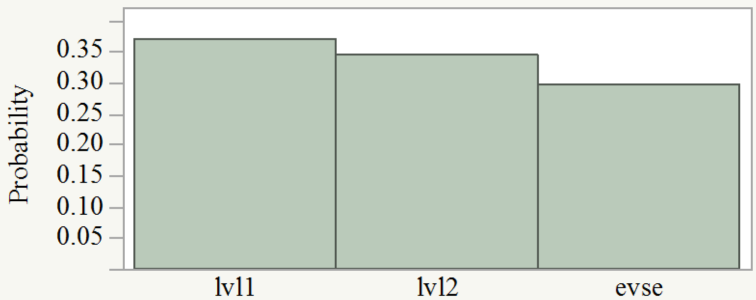


Frequencies

Level	Count	Prob
50	7	0.03977
75	25	0.14205
100	45	0.25568
125	12	0.06818
150	18	0.10227
200	22	0.12500
300	47	0.26705
Total	176	1.00000

N Missing 1495
7 Levels

Game 1: BEV home charge level



Frequencies

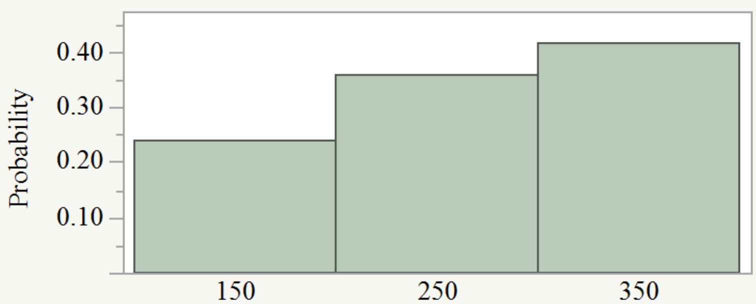
Level	Count	Prob
lvl1	56	0.36601
lvl2	52	0.33987
evse	45	0.29412
Total	153	1.00000

N Missing 1518
3 Levels

80 participants included the quick charge option in their BEV design.

Attributes of FCEVs

Game 1: FCEV range



Frequencies

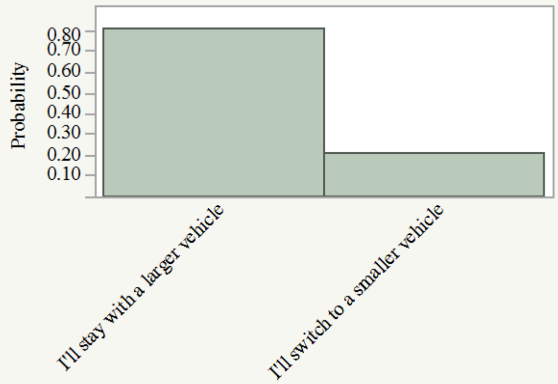
Level	Count	Prob
150	16	0.23529
250	24	0.35294
350	28	0.41176
Total	68	1.00000

N Missing 1603
3 Levels

266 participants chose the FCEV home fueling option.

Game 2 Results: Only people who design full-size vehicles with battery-powered all-electric operation (PHEVs with all-electric charge-depleting operation or BEVs) play Game 2. The game requires them to choose between keeping full-size design or all-electric operation.

Game 2: small or large vehicle

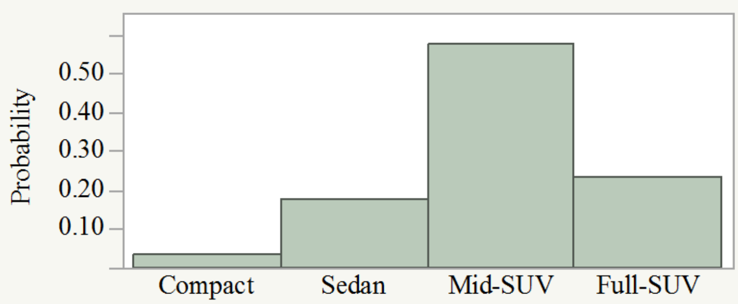


Frequencies

Level	Count	Prob
I'll stay with a larger vehicle	28	0.80000
I'll switch to a smaller vehicle	7	0.20000
Total	35	1.00000

N Missing 1636
2 Levels

Game 2 Body style design

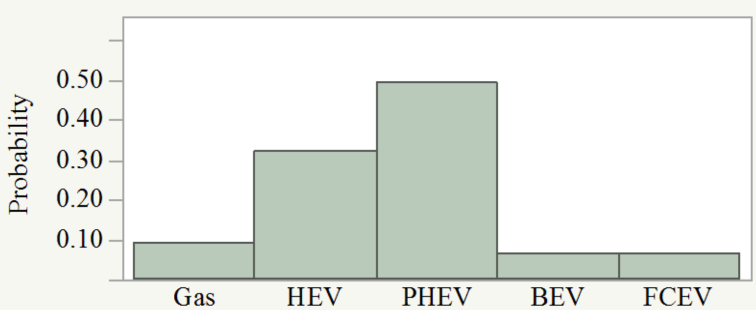


Frequencies

Level	Count	Prob
Compact	1	0.02857
Sedan	6	0.17143
Mid-SUV	20	0.57143
Full-SUV	8	0.22857
Total	35	1.00000

N Missing 1636
4 Levels

Game 2 Drivetrain type



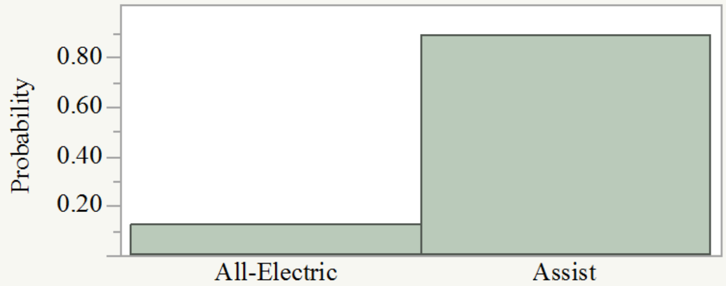
Frequencies

Level	Count	Prob
Gas	3	0.08571
HEV	11	0.31429
PHEV	17	0.48571
BEV	2	0.05714
FCEV	2	0.05714
Total	35	1.00000

N Missing 1636
5 Levels

PHEV, BEV, and FCEV attributes

Game 2 PHEV mode

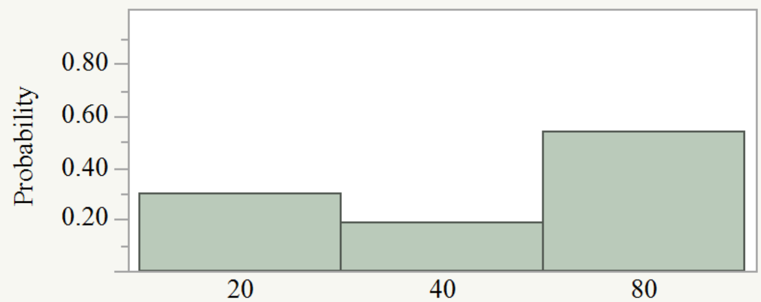


Frequencies

Level	Count	Prob
All-Electric	2	0.11765
Assist	15	0.88235
Total	17	1.00000

N Missing 1654
2 Levels

Game 2 PHEV range

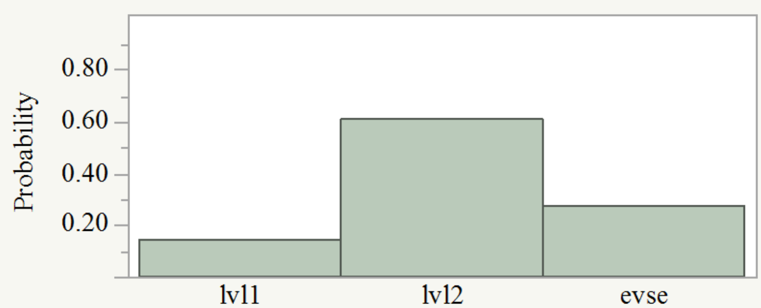


Frequencies

Level	Count	Prob
20	5	0.29412
40	3	0.17647
80	9	0.52941
Total	17	1.00000

N Missing 1654
3 Levels

Game 2 PHEV home charge



Frequencies

Level	Count	Prob
lvl1	2	0.13333
lvl2	9	0.60000
evse	4	0.26667
Total	15	1.00000

N Missing 1656
3 Levels

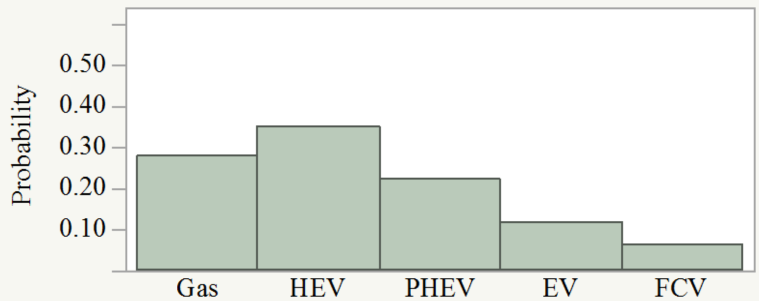
Eight participants chose the PHEV quick charge option.

One participant chose the BEV level 1 home charging option and zero chose the BEV quick charge option.

Two participants chose an FCEV with a 250 mile range and two chose the home fueling option.

Game 3 Results: Starting vehicle is respondent's Game 1 or Game 2 design, as appropriate. Incentives are offered.

Game 3: drivetrain design



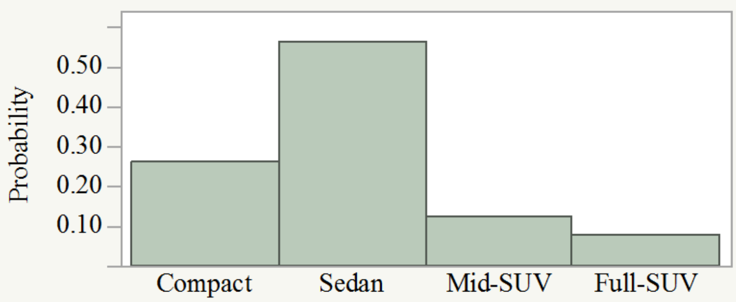
Frequencies

Level	Count	Prob
Gas	459	0.27518
HEV	574	0.34412
PHEV	358	0.21463
EV	184	0.11031
FCV	93	0.05576
Total	1668	1.00000

N Missing 3

5 Levels

Game 3: body style design



Frequencies

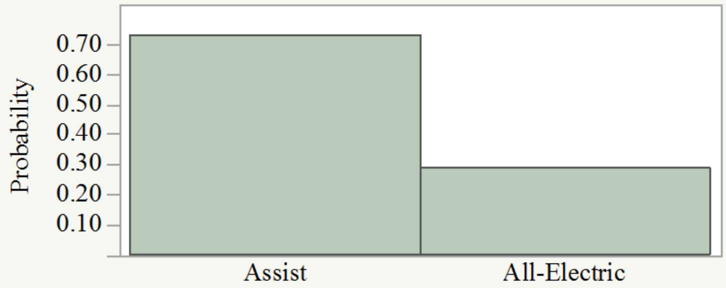
Level	Count	Prob
Compact	426	0.25509
Sedan	930	0.55689
Mid-SUV	197	0.11796
Full-SUV	117	0.07006
Total	1670	1.00000

N Missing 1

4 Levels

PHEV attributes

Game 3 PHEV mode

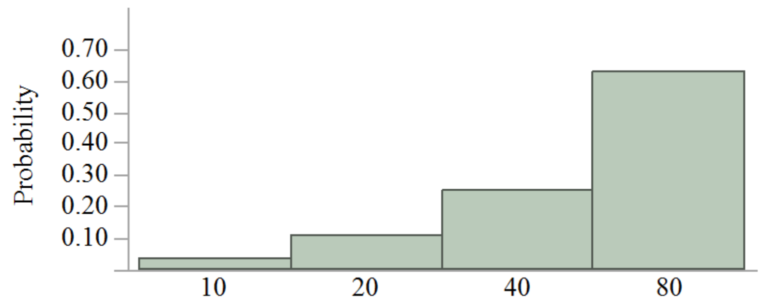


Frequencies

Level	Count	Prob
Assist	258	0.72067
All-Electric	100	0.27933
Total	358	1.00000

N Missing 1313
2 Levels

Game 3 PHEV range

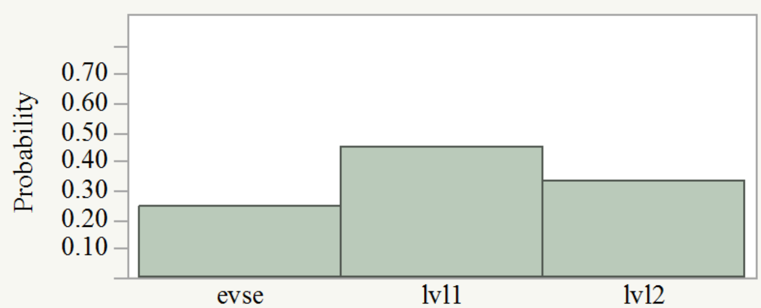


Frequencies

Level	Count	Prob
10	9	0.03125
20	29	0.10069
40	71	0.24653
80	179	0.62153
Total	288	1.00000

N Missing 1383
4 Levels

Game 3 PHEV home charge



Frequencies

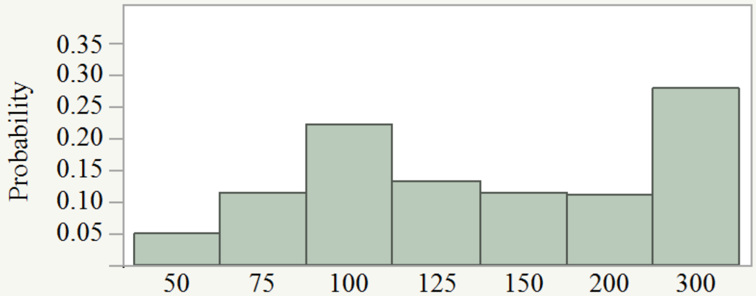
Level	Count	Prob
evse	79	0.23512
lvl1	148	0.44048
lvl2	109	0.32440
Total	336	1.00000

N Missing 1335
3 Levels

146 participants chose the PHEV quick charge option.

BEV attributes

Game 3 BEV range

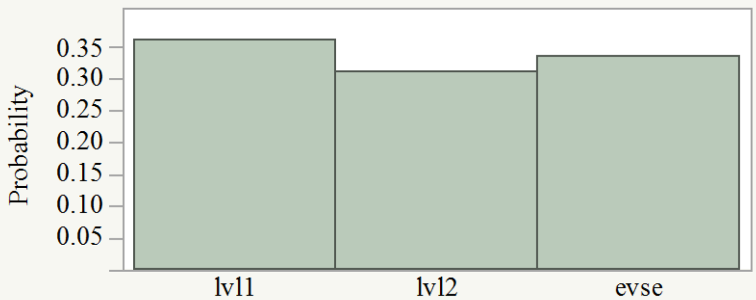


Frequencies

Level	Count	Prob
50	8	0.04706
75	19	0.11176
100	37	0.21765
125	22	0.12941
150	19	0.11176
200	18	0.10588
300	47	0.27647
Total	170	1.00000

N Missing 1501
7 Levels

Game 3 BEV home charging



Frequencies

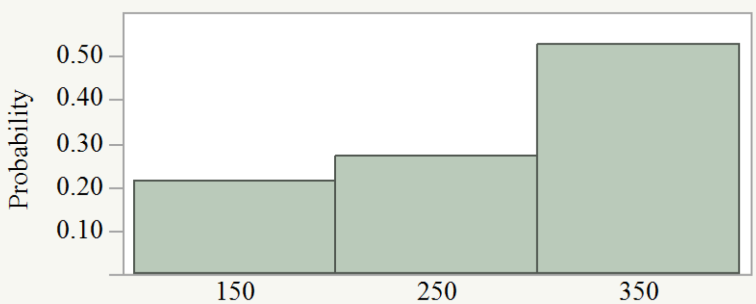
Level	Count	Prob
lvl1	58	0.35802
lvl2	50	0.30864
evse	54	0.33333
Total	162	1.00000

N Missing 1509
3 Levels

74 participants chose the BEV quick charging option.

FCEV attributes

Game 3 FCEV range



Frequencies

Level	Count	Prob
150	14	0.20896
250	18	0.26866
350	35	0.52239
Total	67	1.00000

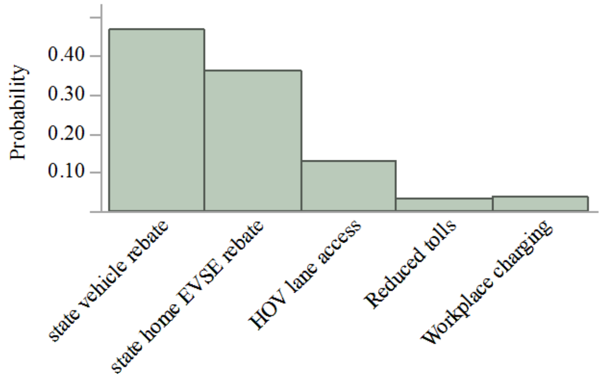
N Missing 1604
3 Levels

42 participants chose the FCEV home fueling option.

Incentives chosen by all qualifying respondents, i.e., those who design PHEVs, BEVs, and FCEVS.

Note that all qualifying respondents were given a federal incentive modeled on the existing tax credit for PEVs. This distribution is the additional incentive they chose.

Game 3: All Incentives



Frequencies

Level	Count	Prob
state vehicle rebate	252	0.46239
state home EVSE rebate	193	0.35413
HOV lane access	68	0.12477
Reduced tolls	14	0.02569
Workplace charging	18	0.03303
Total	545	1.00000

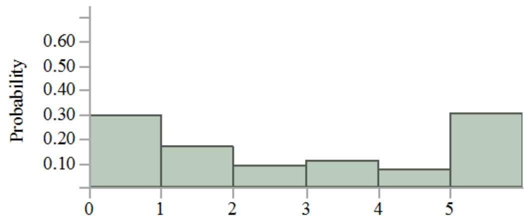
N Missing 1126
5 Levels

Motivations to design a PHEV, BEV, or FCEV

Respondents who designed their next new vehicle to be a PHEV, BEV, or FCEV assign zero to five points per motivation; more points means it was more important.

Interest in ZEV technology

Pro-ZEV: tech



Quantiles

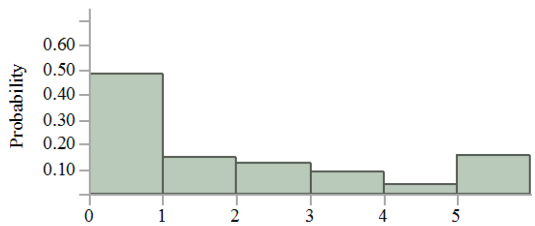
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	5
50.0%	median	2
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	2.3817035
Std Dev	2.0528667
Std Err Mean	0.0815298
Upper 95% Mean	2.541805
Lower 95% Mean	2.221602
N	634
Sum Wgt	634
Sum	1510

Fun to drive

Pro-ZEV: fun



Quantiles

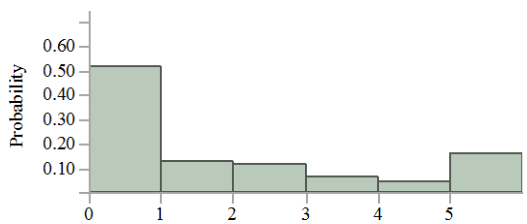
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	3
50.0%	median	1
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.4873817
Std Dev	1.8285083
Std Err Mean	0.0726193
Upper 95% Mean	1.6299857
Lower 95% Mean	1.3447777
N	634
Sum Wgt	634
Sum	943

It will be safer than gasoline or diesel vehicles

Pro-ZEV: safer



Quantiles

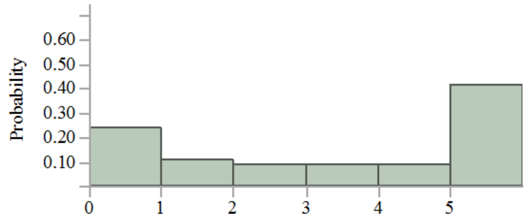
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	3
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.464455
Std Dev	1.8773509
Std Err Mean	0.074618
Upper 95% Mean	1.6109842
Lower 95% Mean	1.3179258
N	633
Sum Wgt	633
Sum	927

To save money on gasoline or diesel fuel

Pro-ZEV: fuel cost



Quantiles

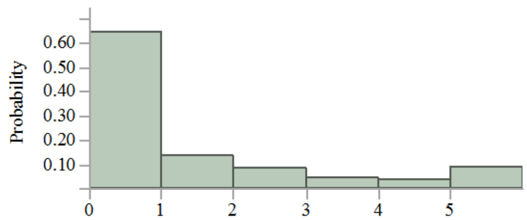
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	5
50.0%	median	3
25.0%	quartile	1
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	2.9115324
Std Dev	2.0772448
Std Err Mean	0.0825631
Upper 95% Mean	3.0736635
Lower 95% Mean	2.7494013
N	633
Sum Wgt	633
Sum	1843

It will be more comfortable

Pro-ZEV: comfortable



Quantiles

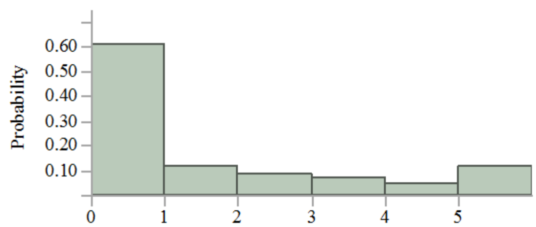
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		4
75.0%	quartile	1
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	0.9447077
Std Dev	1.5786675
Std Err Mean	0.0627464
Upper 95% Mean	1.0679244
Lower 95% Mean	0.8214911
N	633
Sum Wgt	633
Sum	598

Like how it looks

Pro-ZEV: looks



Quantiles

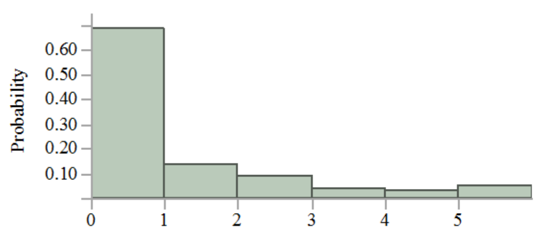
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	2
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.1561514
Std Dev	1.7368513
Std Err Mean	0.0689792
Upper 95% Mean	1.2916071
Lower 95% Mean	1.0206957
N	634
Sum Wgt	634
Sum	733

Makes the right impression for family, friends, and others

Pro-ZEV: impression



Quantiles

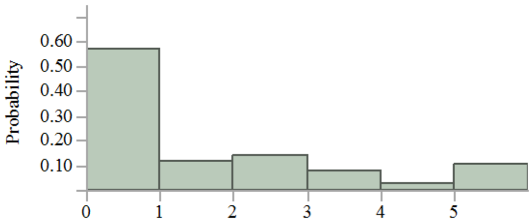
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		3
75.0%	quartile	1
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	0.7239748
Std Dev	1.3222459
Std Err Mean	0.0525131
Upper 95% Mean	0.8270957
Lower 95% Mean	0.6208538
N	634
Sum Wgt	634
Sum	459

Fits lifestyle/activities

Pro-ZEV: lifestyle



Quantiles

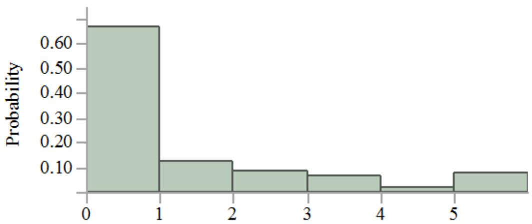
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		4
75.0%	quartile	2
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.1545741
Std Dev	1.6353383
Std Err Mean	0.0649476
Upper 95% Mean	1.2821129
Lower 95% Mean	1.0270354
N	634
Sum Wgt	634
Sum	732

Save on the cost of the vehicle purchase

Pro-ZEV: purchase cost



Quantiles

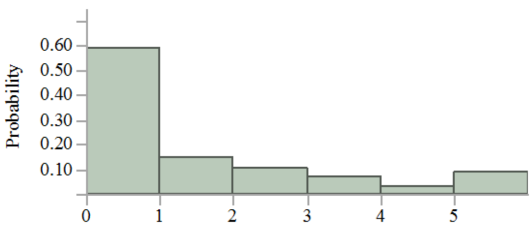
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		3
75.0%	quartile	1
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	0.8611987
Std Dev	1.4891845
Std Err Mean	0.0591431
Upper 95% Mean	0.9773391
Lower 95% Mean	0.7450584
N	634
Sum Wgt	634
Sum	546

Save on the cost of maintenance and upkeep

Pro-ZEV: maintenance cost



Quantiles

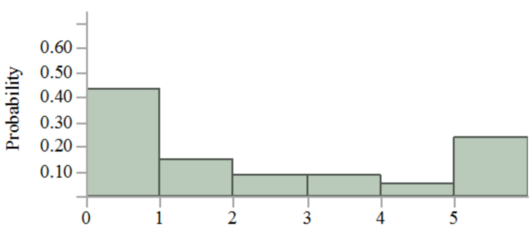
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		4
75.0%	quartile	2
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.0615142
Std Dev	1.591149
Std Err Mean	0.0631926
Upper 95% Mean	1.1856067
Lower 95% Mean	0.9374217
N	634
Sum Wgt	634
Sum	673

Will reduce the effect on climate change of their driving

Pro-ZEV: climate change



Quantiles

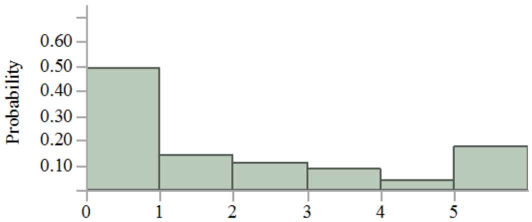
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	4
50.0%	median	1
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.8675079
Std Dev	2.0409979
Std Err Mean	0.0810584
Upper 95% Mean	2.0266837
Lower 95% Mean	1.708332
N	634
Sum Wgt	634
Sum	1184

Will reduce the amount of oil that is imported to the United States

Pro-ZEV: oil imports



Quantiles

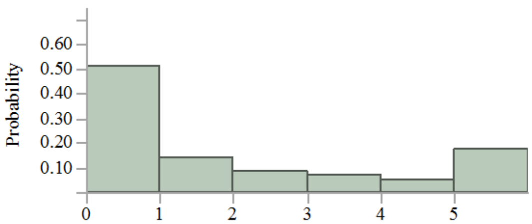
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	3
50.0%	median	1
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.544164
Std Dev	1.8958937
Std Err Mean	0.0752956
Upper 95% Mean	1.6920233
Lower 95% Mean	1.3963047
N	634
Sum Wgt	634
Sum	979

Will pay less money to oil companies or foreign oil producing nations

Pro-ZEV: money to oil producers



Quantiles

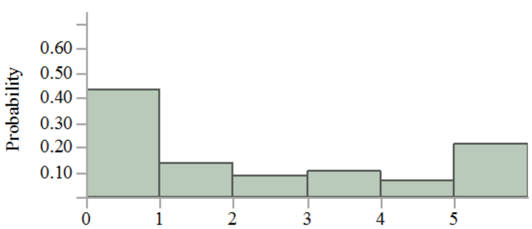
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	3
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.5189274
Std Dev	1.9244305
Std Err Mean	0.0764289
Upper 95% Mean	1.6690123
Lower 95% Mean	1.3688426
N	634
Sum Wgt	634
Sum	963

Will reduce the effect on air quality of their driving

Pro-ZEV: air quality



Quantiles

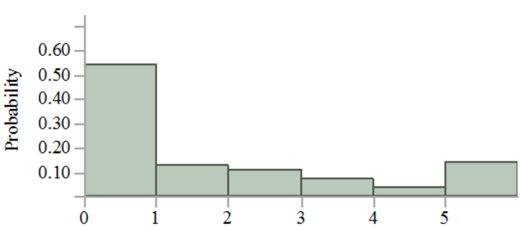
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	4
50.0%	median	1
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.8359621
Std Dev	2.0019501
Std Err Mean	0.0795076
Upper 95% Mean	1.9920927
Lower 95% Mean	1.6798316
N	634
Sum Wgt	634
Sum	1164

Convenient to charge the vehicle at home

Pro-ZEV: home charge convenience



Quantiles

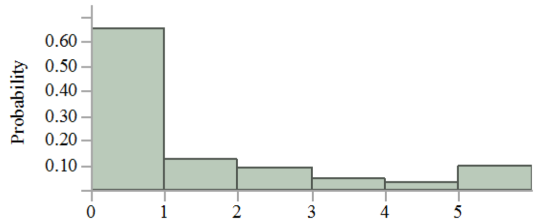
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	2
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.3475513
Std Dev	1.8200443
Std Err Mean	0.0723403
Upper 95% Mean	1.4896077
Lower 95% Mean	1.205495
N	633
Sum Wgt	633
Sum	853

Incentives made it too attractive to pass up

Pro-ZEV: incentives



Quantiles

100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		4
75.0%	quartile	1
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

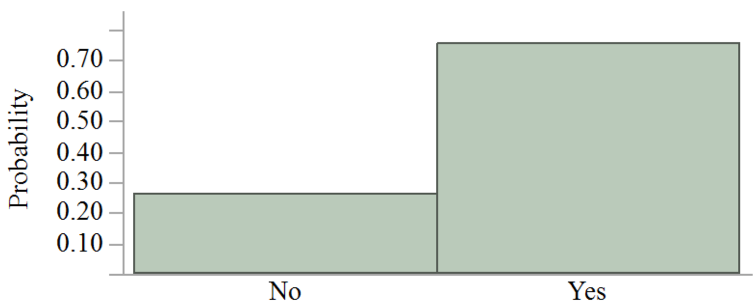
Summary Statistics

Mean	0.9337539
Std Dev	1.5824959
Std Err Mean	0.0628489
Upper 95% Mean	1.0571716
Lower 95% Mean	0.8103363
N	634
Sum Wgt	634
Sum	592

50 participants cited an “other” reason why they designed a PHEV, BEV, or FCEV. These other reasons included some they had already been offered, including: better for the environment, save money, move away from fossil fuels, like the way the vehicles look, or think they are fun. Some were elaborations or specifications of previously offered reasons and a few were new: best for the economy, access to HOV lanes, a more efficient vehicle, or they know someone with a hybrid or plug-in hybrid.

Did they think about how much gasoline, electricity, or hydrogen would cost them when making their vehicle designs.

Pro-ZEV: consider fuel cost



Frequencies

Level	Count	Prob
No	160	0.25197
Yes	475	0.74803
Total	635	1.00000

N Missing 1036

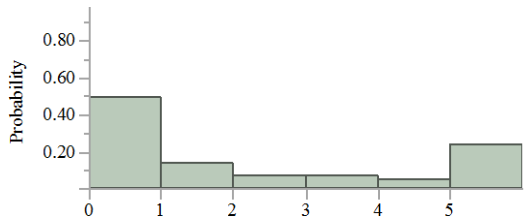
2 Levels

Motivations against designing a PHEV, BEV, or FCEV among those who did not.

Respondents who did not design their next new vehicle to be a PHEV, BEV, or FCEV assign zero to five points per motivation; more points means it was more important.

Unfamiliar with ZEV technology

Non-ZEV: unfamiliar technology

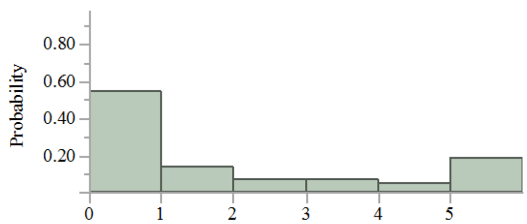


Quantiles		
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	4
50.0%	median	1
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics	
Mean	1.7281349
Std Dev	2.0673927
Std Err Mean	0.0671104
Upper 95% Mean	1.859837
Lower 95% Mean	1.5964327
N	949
Sum Wgt	949
Sum	1640

Concern about unreliable electricity, e.g. blackouts and overall supply

Non-ZEV: electricity supply

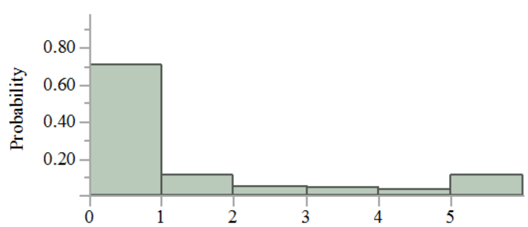


Quantiles		
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	3
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics	
Mean	1.4736287
Std Dev	1.9492886
Std Err Mean	0.06331
Upper 95% Mean	1.5978727
Lower 95% Mean	1.3493847
N	948
Sum Wgt	948
Sum	1397

Concern about vehicle safety

Non-ZEV: vehicle safety

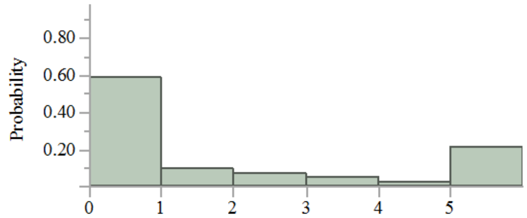


Quantiles		
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	1
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics	
Mean	0.8988409
Std Dev	1.6568133
Std Err Mean	0.0537824
Upper 95% Mean	1.0043873
Lower 95% Mean	0.7932945
N	949
Sum Wgt	949
Sum	853

Can’t charge a vehicle with electricity or fuel one with natural gas at home

Non-ZEV: no home charge or fuel



Quantiles

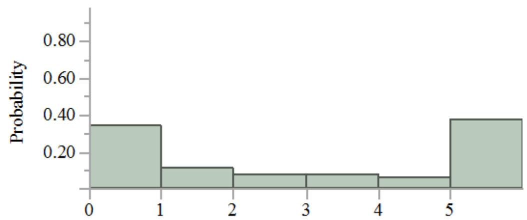
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	3
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.4515789
Std Dev	2.0212967
Std Err Mean	0.0655795
Upper 95% Mean	1.5802766
Lower 95% Mean	1.3228813
N	950
Sum Wgt	950
Sum	1379

Limited number of places to charge or fuel away from home

Non-ZEV: limited fuel network



Quantiles

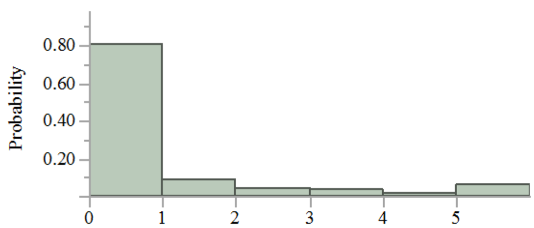
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	5
50.0%	median	2
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	2.5136842
Std Dev	2.1832107
Std Err Mean	0.0708327
Upper 95% Mean	2.6526911
Lower 95% Mean	2.3746774
N	950
Sum Wgt	950
Sum	2388

Don’t like how they look

Non-ZEV: looks



Quantiles

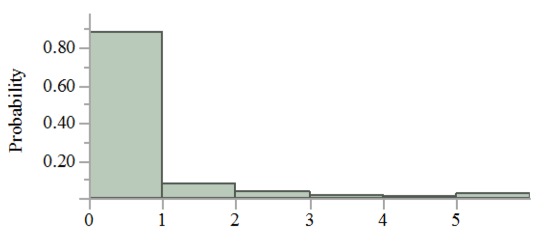
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		2
75.0%	quartile	0
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	0.5252632
Std Dev	1.2890451
Std Err Mean	0.0418221
Upper 95% Mean	0.6073377
Lower 95% Mean	0.4431886
N	950
Sum Wgt	950
Sum	499

Don’t think they make the right impression

Non-ZEV: impression



Quantiles

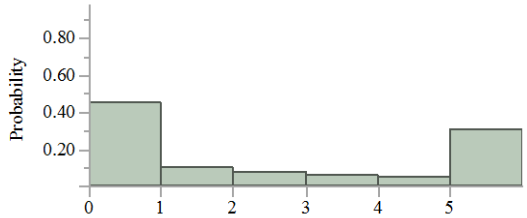
100.0%	maximum	5
99.5%		5
97.5%		3
90.0%		1
75.0%	quartile	0
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	0.2557895
Std Dev	0.8494982
Std Err Mean	0.0275614
Upper 95% Mean	0.3098777
Lower 95% Mean	0.2017012
N	950
Sum Wgt	950
Sum	243

Cost of vehicle purchase

Non-ZEV: purchase cost

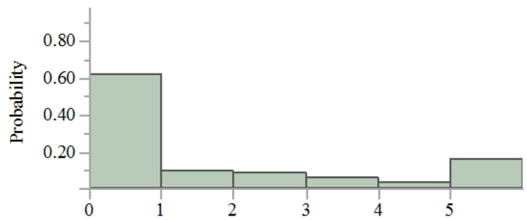


Quantiles		
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	5
50.0%	median	1
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics	
Mean	2.0790306
Std Dev	2.1905707
Std Err Mean	0.0711089
Upper 95% Mean	2.2185797
Lower 95% Mean	1.9394814
N	949
Sum Wgt	949
Sum	1973

Cost of maintenance and upkeep

Non-ZEV: maintenance cost

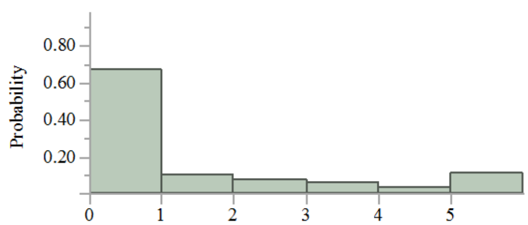


Quantiles		
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	2
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics	
Mean	1.2347368
Std Dev	1.8626872
Std Err Mean	0.0604336
Upper 95% Mean	1.3533357
Lower 95% Mean	1.116138
N	950
Sum Wgt	950
Sum	1173

Cost to charge or fuel

Non-ZEV: fuel cost

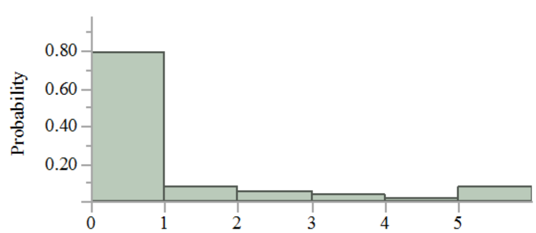


Quantiles		
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	1
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics	
Mean	0.9915789
Std Dev	1.6754386
Std Err Mean	0.0543584
Upper 95% Mean	1.0982555
Lower 95% Mean	0.8849024
N	950
Sum Wgt	950
Sum	942

Doesn’t fit lifestyle/activities

Non-ZEV: lifestyle

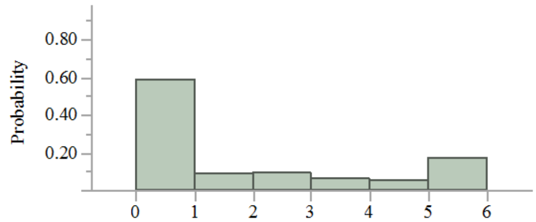


Quantiles		
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		3
75.0%	quartile	0
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics	
Mean	0.6021053
Std Dev	1.3907703
Std Err Mean	0.0451225
Upper 95% Mean	0.6906568
Lower 95% Mean	0.5135538
N	950
Sum Wgt	950
Sum	572

Concern about time needed to charge or fuel vehicle

Non-ZEV: charge/fuel time



Quantiles

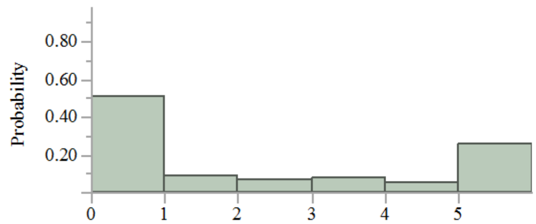
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	3
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.3905263
Std Dev	1.9292313
Std Err Mean	0.0625925
Upper 95% Mean	1.5133621
Lower 95% Mean	1.2676906
N	950
Sum Wgt	950
Sum	1321

Distance on a battery charge or tank of natural gas is too limited

Non-ZEV: range



Quantiles

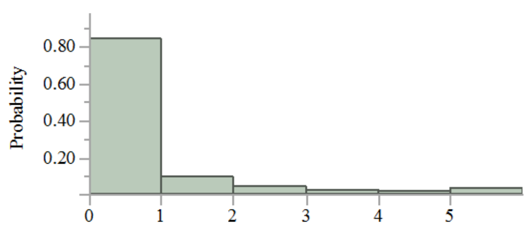
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	4
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.8157895
Std Dev	2.1322856
Std Err Mean	0.0691805
Upper 95% Mean	1.9515539
Lower 95% Mean	1.6800251
N	950
Sum Wgt	950
Sum	1725

Concern about safety of electricity or natural gas

Non-ZEV: fuel safety



Quantiles

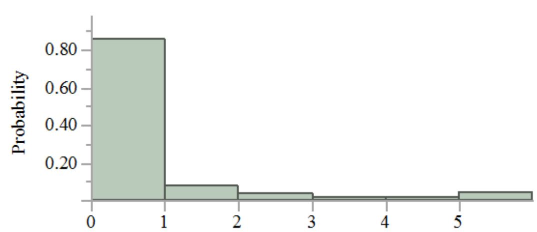
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		1
75.0%	quartile	0
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	0.3663158
Std Dev	1.0237033
Std Err Mean	0.0332133
Upper 95% Mean	0.4314958
Lower 95% Mean	0.3011357
N	950
Sum Wgt	950
Sum	348

Environmental Concerns

Non-ZEV: enviormental concerns



Quantiles

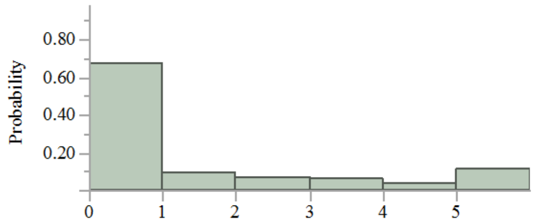
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		1
75.0%	quartile	0
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	0.3463158
Std Dev	1.0332013
Std Err Mean	0.0335215
Upper 95% Mean	0.4121006
Lower 95% Mean	0.280531
N	950
Sum Wgt	950
Sum	329

Concerns about batteries

Non-ZEV: battery concerns



Quantiles

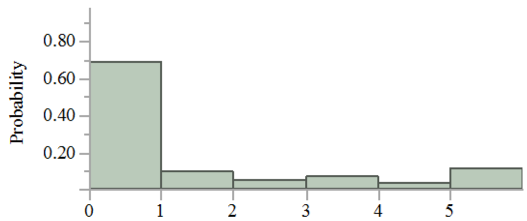
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	1
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.0115789
Std Dev	1.7007011
Std Err Mean	0.055178
Upper 95% Mean	1.119864
Lower 95% Mean	0.9032939
N	950
Sum Wgt	950
Sum	961

Waiting for technology to become more reliable

Non-ZEVs: reliability



Quantiles

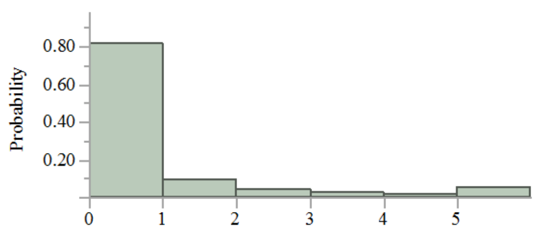
100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	1
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	0.9642105
Std Dev	1.6869871
Std Err Mean	0.0547331
Upper 95% Mean	1.0716224
Lower 95% Mean	0.8567987
N	950
Sum Wgt	950
Sum	916

Higher incentives would have convinced me

Non-ZEVs: higher incentives



Quantiles

100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		2
75.0%	quartile	0
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

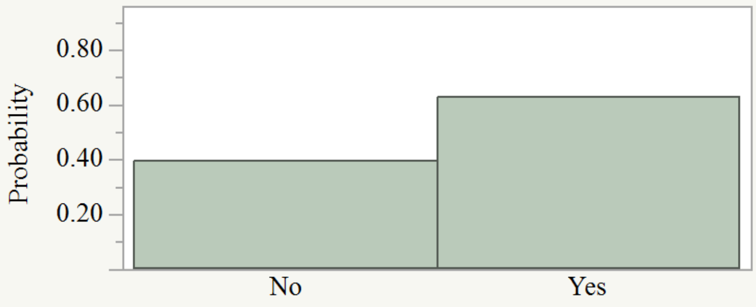
Summary Statistics

Mean	0.4663158
Std Dev	1.1911255
Std Err Mean	0.0386452
Upper 95% Mean	0.5421557
Lower 95% Mean	0.3904758
N	950
Sum Wgt	950
Sum	443

54 participants cited the following reasons for *not* selecting a PHEV, BEV, or FCEV: concerned about limited power performance, concerned about explosions, the cost of the vehicle is too high, they don’t want the government involved in their vehicle choice, had numerous problems with hybrid, hate the way they look, lack experience with alternative fuels, refuse to support liberal agenda, not interested, lack a spare tire, don’t want to help develop technology, needs a larger sized vehicle to support family and/or gear, incentives don’t help them, they aren’t worth the effort and cost, battery replacement cost of $10k is too high, travel long distances for work, prefer a vehicle that’s fun to drive, worried about losing electricity during an earthquake or storm.

Did they think about how much gasoline, electricity, or hydrogen would cost them when making their vehicle designs.

Non-ZEV: consider fuel cost



Frequencies

Level	Count	Prob
No	366	0.38445
Yes	586	0.61555
Total	952	1.00000

N Missing 719

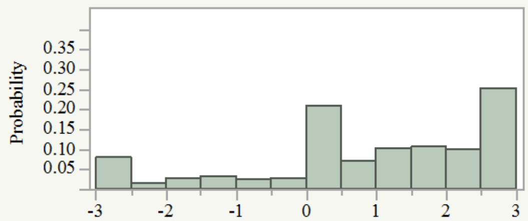
2 Levels

Attitudes toward policy goals

Distributions truncated to eliminate non-responses. -3= strongly disagree; 3= strongly agree

There is an urgent national need to replace gasoline and diesel for our cars and trucks with other sources of energy.

Urgent national need (trunc)



Quantiles

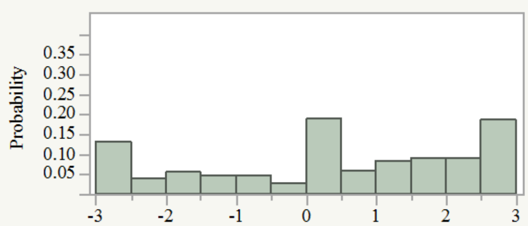
100.0%	maximum	2.99
99.5%		2.97
97.5%		2.94
90.0%		2.88
75.0%	quartile	2.49
50.0%	median	1.29
25.0%	quartile	0
10.0%		-1.623
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	0.9523832
Std Dev	1.6994236
Std Err Mean	0.044537
Upper 95% Mean	1.0397468
Lower 95% Mean	0.8650197
N	1456

If government would not interfere, the market would provide all the incentive required for automobile makers to sell vehicles that get their energy from electricity and hydrogen.

Market incentives (trunc)



Quantiles

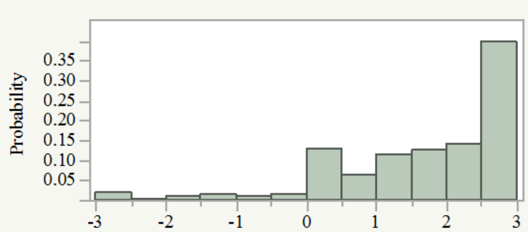
100.0%	maximum	2.99
99.5%		2.97
97.5%		2.92
90.0%		2.831
75.0%	quartile	2.13
50.0%	median	0.38
25.0%	quartile	-1.07
10.0%		-2.811
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	0.3911787
Std Dev	1.9139154
Std Err Mean	0.0531233
Upper 95% Mean	0.4953958
Lower 95% Mean	0.2869616
N	1298

Air pollution can be reduced if individuals make changes in their lifestyle.

Air pollution: lifestyle (trunc)



Quantiles

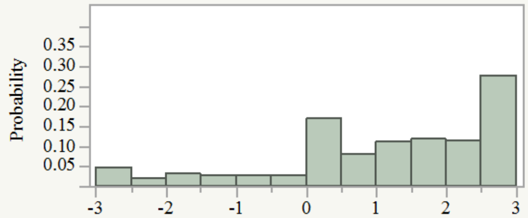
100.0%	maximum	2.99
99.5%		2.98295
97.5%		2.95
90.0%		2.9
75.0%	quartile	2.8
50.0%	median	2.12
25.0%	quartile	1.06
10.0%		0
2.5%		-1.45375
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	1.7382922
Std Dev	1.251413
Std Err Mean	0.031889
Upper 95% Mean	1.8008426
Lower 95% Mean	1.6757418
N	1540

I personally worry about air pollution.

Air pollution: personal worry (trunc)



Quantiles

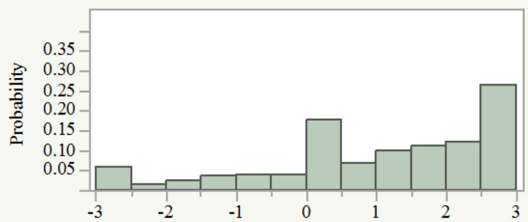
100.0%	maximum	2.99
99.5%		2.98
97.5%		2.94
90.0%		2.87
75.0%	quartile	2.58
50.0%	median	1.485
25.0%	quartile	0
10.0%		-1.24
2.5%		-2.93
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	1.1548251
Std Dev	1.5990319
Std Err Mean	0.0406943
Upper 95% Mean	1.2346471
Lower 95% Mean	1.0750032
N	1544

Air pollution is a health threat in my region.

Air pollution: regional threat (trunc)



Quantiles

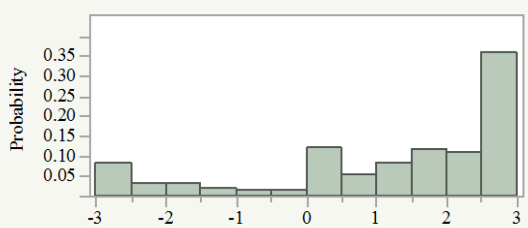
100.0%	maximum	2.99
99.5%		2.98
97.5%		2.94
90.0%		2.88
75.0%	quartile	2.54
50.0%	median	1.44
25.0%	quartile	0
10.0%		-1.334
2.5%		-2.95
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	1.0637366
Std Dev	1.6479182
Std Err Mean	0.0427203
Upper 95% Mean	1.147535
Lower 95% Mean	0.9799381
N	1488

There is evidence that the average temperature on Earth has been getting warmer over the past several decades. Distribution truncated to eliminate non-responses.

Global warming: certainty (trunc)



Quantiles

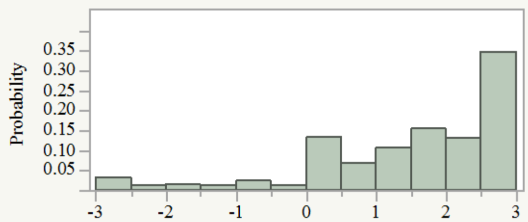
100.0%	maximum	2.99
99.5%		2.99
97.5%		2.95
90.0%		2.89
75.0%	quartile	2.79
50.0%	median	1.82
25.0%	quartile	0
10.0%		-2.08
2.5%		-3
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	1.2110943
Std Dev	1.8221066
Std Err Mean	0.0488903
Upper 95% Mean	1.3070012
Lower 95% Mean	1.1151875
N	1389

The Earth is getting warmer mostly because of natural processes or human activity. Distribution truncated to eliminate non-responses. Asked only of the those whose answer to the previous question was equal to or greater than zero.

Global warming: natural or human cause (trunc)



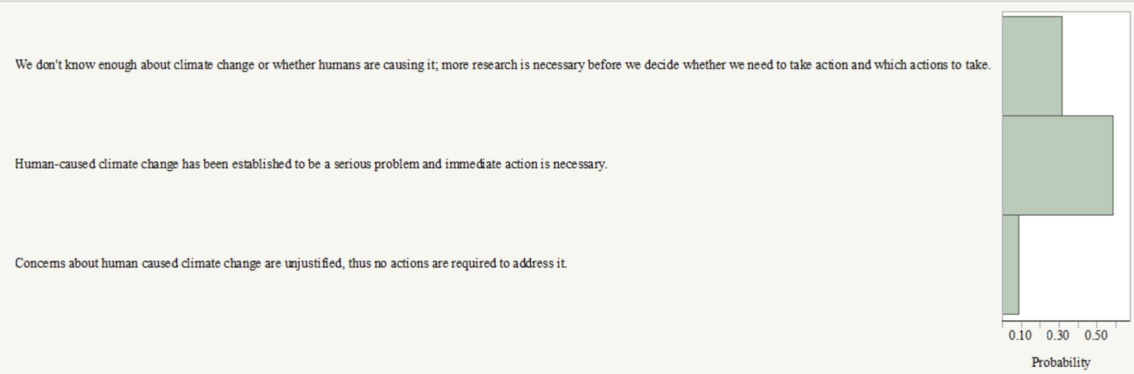
Quantiles

100.0%	maximum	2.99
99.5%		2.98
97.5%		2.95
90.0%		2.88
75.0%	quartile	2.7125
50.0%	median	1.91
25.0%	quartile	0.8175
10.0%		0
2.5%		-2.6045
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	1.565419
Std Dev	1.3798315
Std Err Mean	0.0425825
Upper 95% Mean	1.6489757
Lower 95% Mean	1.4818624
N	1050

Climate Change: action



Frequencies

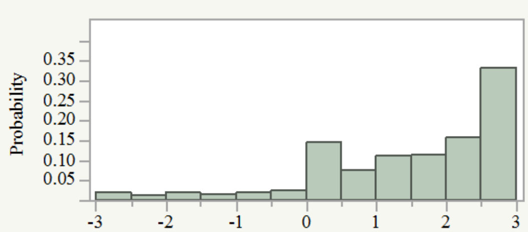
Level	Count	Prob
Concerns about human caused climate change are unjustified, thus no actions are required to address it.	148	0.08857
Human-caused climate change has been established to be a serious problem and immediate action is necessary.	987	0.59066
We don't know enough about climate change or whether humans are causing it; more research is necessary before we decide whether we need to take action and which actions to take.	536	0.32077
Total	1671	1.00000

N Missing 0

3 Levels

Climate change can be reduced if individuals make changes in their lifestyle. Distribution truncated to eliminate non-responses. -3= strongly disagree; 3= strongly agree

Climate change: lifestyle (trunc)



Quantiles

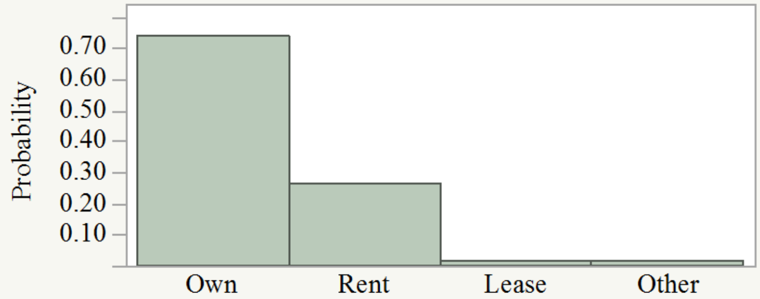
100.0%	maximum	2.99
99.5%		2.98
97.5%		2.94
90.0%		2.88
75.0%	quartile	2.7
50.0%	median	1.91
25.0%	quartile	0.5975
10.0%		0
2.5%		-2.04375
0.5%		-3
0.0%	minimum	-3

Summary Statistics

Mean	1.532187
Std Dev	1.3470579
Std Err Mean	0.0365541
Upper 95% Mean	1.6038958
Lower 95% Mean	1.4604783
N	1358

Demographic, socio-economic and other descriptor

Own or rent residence



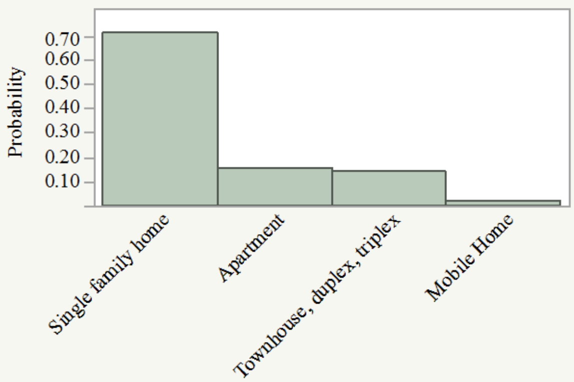
Frequencies

Level	Count	Prob
Own	1224	0.73250
Rent	427	0.25554
Lease	7	0.00419
Other	13	0.00778
Total	1671	1.00000

N Missing 0
4 Levels

Those who don't own, rent, or lease live with relatives.

Residence Type



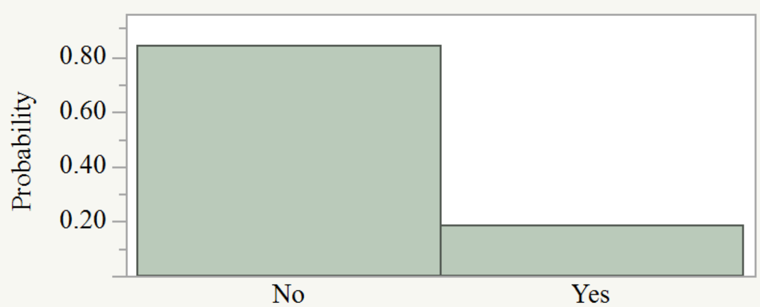
Frequencies

Level	Count	Prob
Single family home	1178	0.70497
Apartment	247	0.14782
Townhouse, duplex, triplex	224	0.13405
Mobile Home	22	0.01317
Total	1671	1.00000

N Missing 0
4 Levels

Do they have a photovoltaic system installed at their residence.

Solar Panels



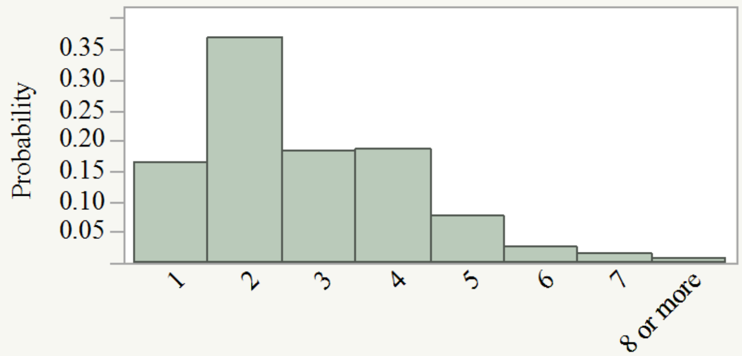
Frequencies

Level	Count	Prob
No	1386	0.82944
Yes	285	0.17056
Total	1671	1.00000

N Missing 0
2 Levels

Number of people in the household

Household size



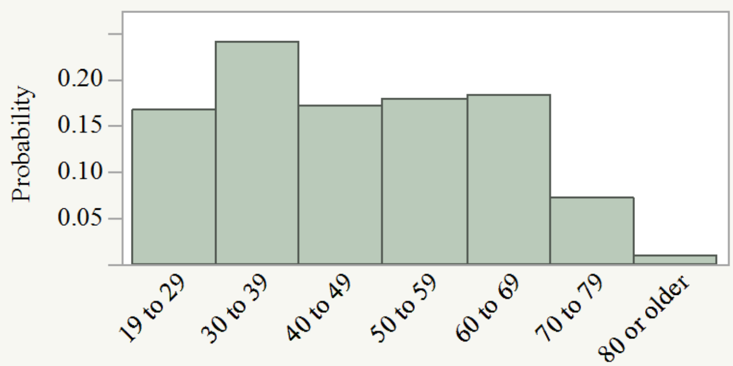
Frequencies

Level	Count	Prob
1	270	0.16158
2	610	0.36505
3	299	0.17893
4	307	0.18372
5	122	0.07301
6	35	0.02095
7	21	0.01257
8 or more	7	0.00419
Total	1671	1.00000

N Missing 0
8 Levels

Respondent age is truncated to eliminate a few responses below 19 years old.

rRespondent Age (trunc)

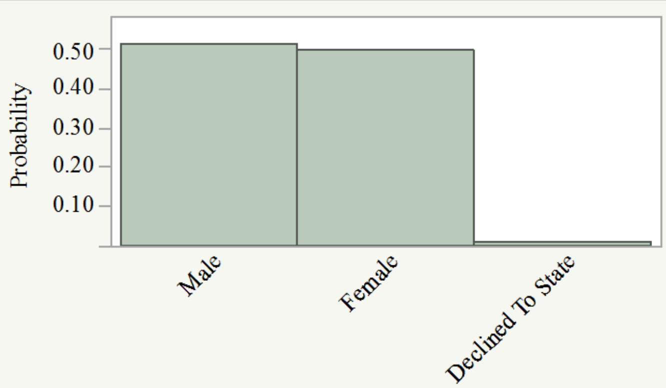


Frequencies

Level	Count	Prob
19 to 29	269	0.16313
30 to 39	392	0.23772
40 to 49	280	0.16980
50 to 59	290	0.17586
60 to 69	296	0.17950
70 to 79	112	0.06792
80 or older	10	0.00606
Total	1649	1.00000

N Missing 22
7 Levels

Respondent Gender

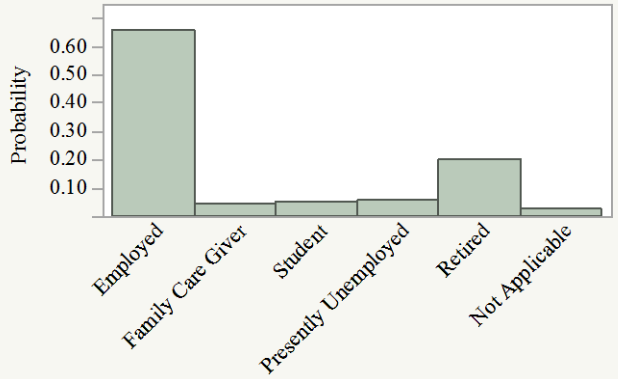


Frequencies

Level	Count	Prob
Male	842	0.50510
Female	820	0.49190
Declined To State	5	0.00300
Total	1667	1.00000

N Missing 4
3 Levels

Respondent Employment



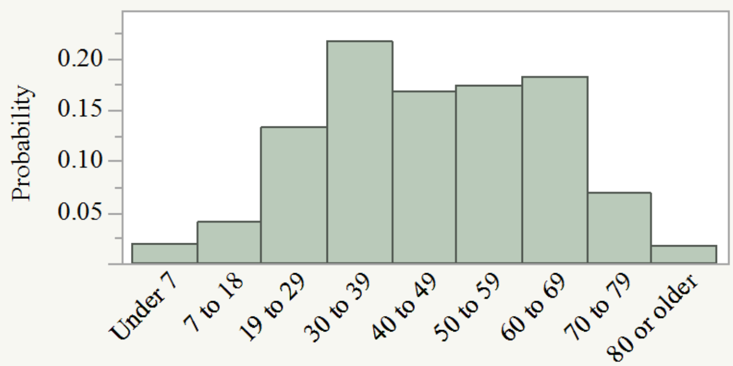
Frequencies

Level	Count	Prob
Employed	1051	0.64957
Family Care Giver	62	0.03832
Student	71	0.04388
Presently Unemployed	89	0.05501
Retired	312	0.19283
Not Applicable	33	0.02040
Total	1618	1.00000

N Missing 53
6 Levels

Description of other household members starts with other licensed drivers, then moves to household members without driver's licenses.

Hhld member 2 age

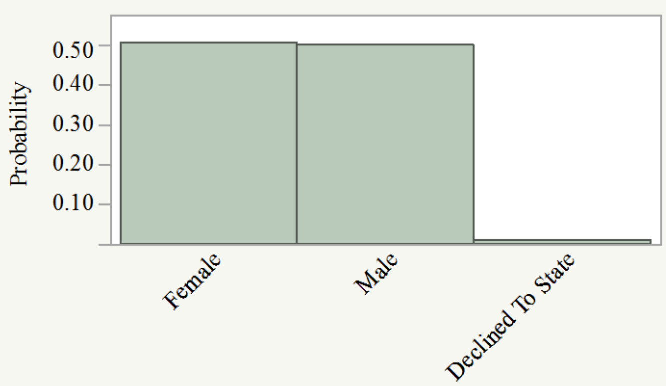


Frequencies

Level	Count	Prob
Under 7	24	0.01734
7 to 18	54	0.03902
19 to 29	181	0.13078
30 to 39	297	0.21460
40 to 49	229	0.16546
50 to 59	237	0.17124
60 to 69	249	0.17991
70 to 79	92	0.06647
80 or older	21	0.01517
Total	1384	1.00000

N Missing 287
9 Levels

Hhld member 2 gender

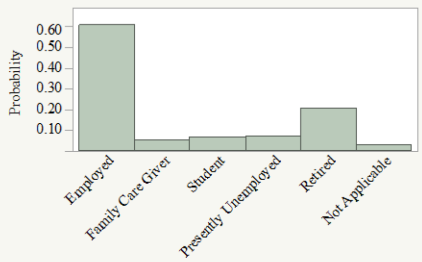


Frequencies

Level	Count	Prob
Female	698	0.50108
Male	689	0.49462
Declined To State	6	0.00431
Total	1393	1.00000

N Missing 278
3 Levels

Hhld member 2 Employment

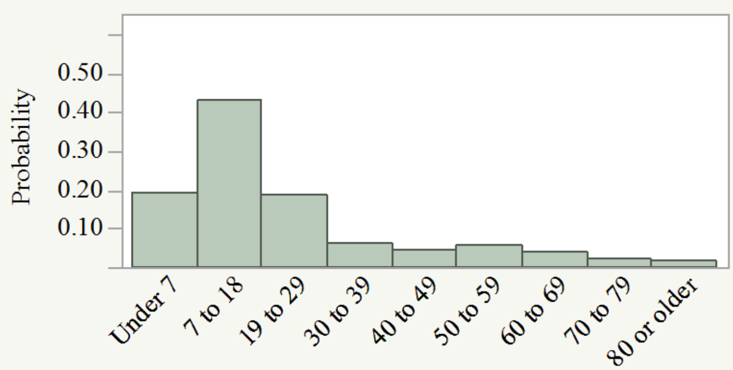


Frequencies

Level	Count	Prob
Employed	801	0.60226
Family Care Giver (not employed outside own home)	63	0.04737
Student	83	0.06241
Presently Unemployed	88	0.06617
Retired	264	0.19850
Not Applicable	31	0.02331
Total	1330	1.00000

N Missing 341
6 Levels

Person 3 age

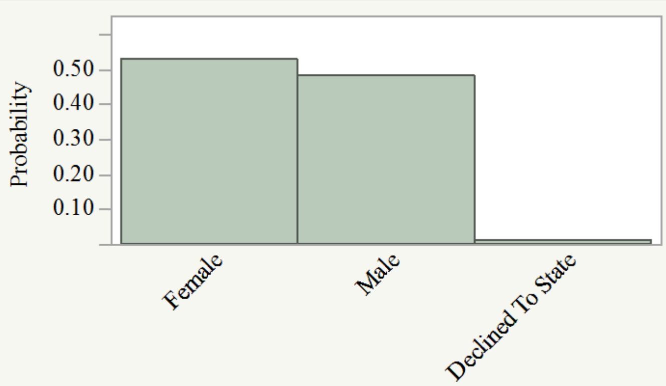


Frequencies

Level	Count	Prob
Under 7	144	0.18605
7 to 18	329	0.42506
19 to 29	139	0.17959
30 to 39	43	0.05556
40 to 49	29	0.03747
50 to 59	40	0.05168
60 to 69	28	0.03618
70 to 79	15	0.01938
80 or older	7	0.00904
Total	774	1.00000

N Missing 897
9 Levels

Person 3 gender

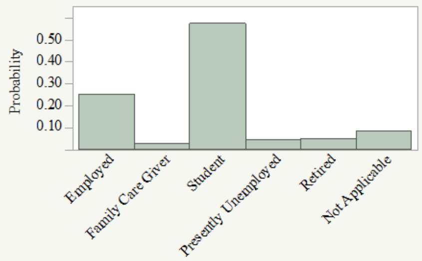


Frequencies

Level	Count	Prob
Female	403	0.51933
Male	368	0.47423
Declined To State	5	0.00644
Total	776	1.00000

N Missing 895
3 Levels

Person 3 work status

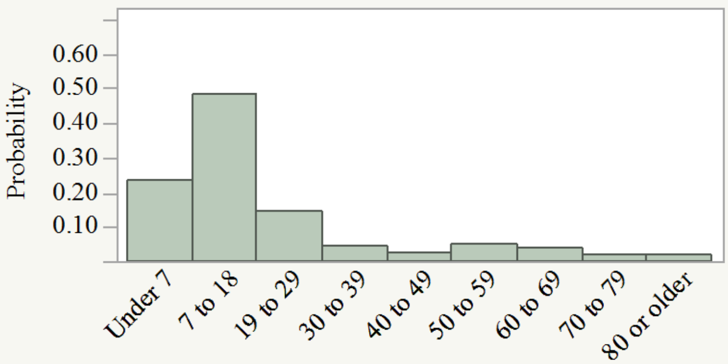


Frequencies

Level	Count	Prob
Employed	156	0.24149
Family Care Giver (not employed outside own home)	15	0.02322
Student	365	0.56502
Presently Unemployed	27	0.04180
Retired	31	0.04799
Not Applicable	52	0.08050
Total	646	1.00000

N Missing 1025
6 Levels

Person 4 age

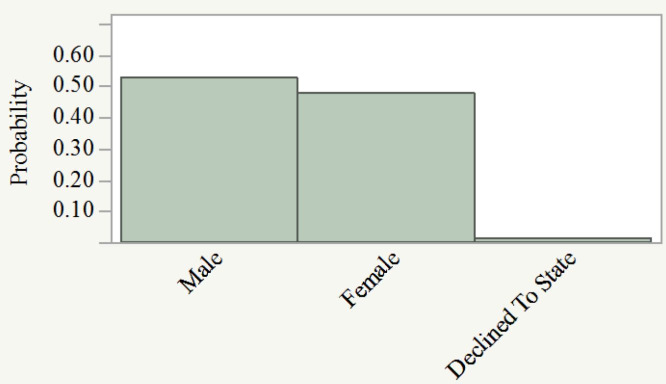


Frequencies

Level	Count	Prob
Under 7	109	0.23093
7 to 18	224	0.47458
19 to 29	66	0.13983
30 to 39	19	0.04025
40 to 49	8	0.01695
50 to 59	20	0.04237
60 to 69	15	0.03178
70 to 79	6	0.01271
80 or older	5	0.01059
Total	472	1.00000

N Missing 1199
9 Levels

Person 4 gender

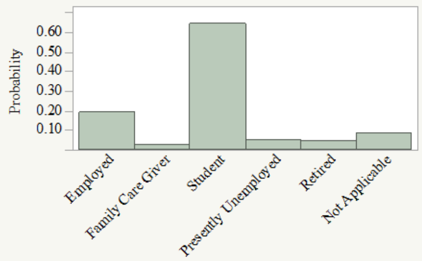


Frequencies

Level	Count	Prob
Male	248	0.52101
Female	225	0.47269
Declined To State	3	0.00630
Total	476	1.00000

N Missing 1195
3 Levels

Person 4 work status

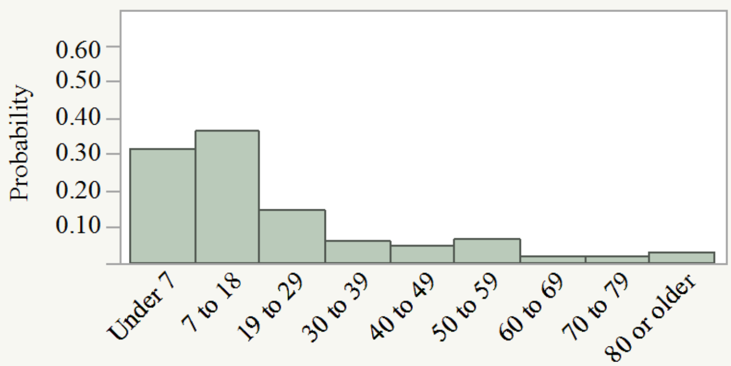


Frequencies

Level	Count	Prob
Employed	70	0.18470
Family Care Giver (not employed outside own home)	8	0.02111
Student	242	0.63852
Presently Unemployed	16	0.04222
Retired	14	0.03694
Not Applicable	29	0.07652
Total	379	1.00000

N Missing 1292
6 Levels

Person 5 age

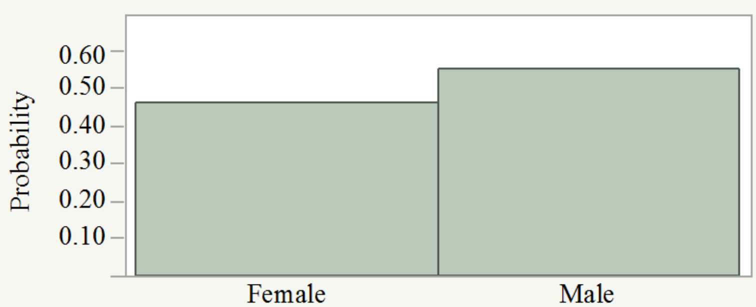


Frequencies

Level	Count	Prob
Under 7	53	0.30814
7 to 18	61	0.35465
19 to 29	24	0.13953
30 to 39	9	0.05233
40 to 49	7	0.04070
50 to 59	10	0.05814
60 to 69	2	0.01163
70 to 79	2	0.01163
80 or older	4	0.02326
Total	172	1.00000

N Missing 1499
9 Levels

Person 5 gender

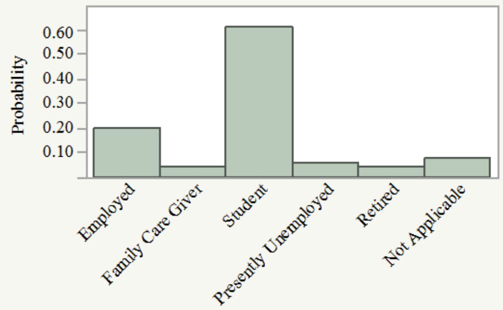


Frequencies

Level	Count	Prob
Female	79	0.45402
Male	95	0.54598
Total	174	1.00000

N Missing 1497
2 Levels

Person 5 work status

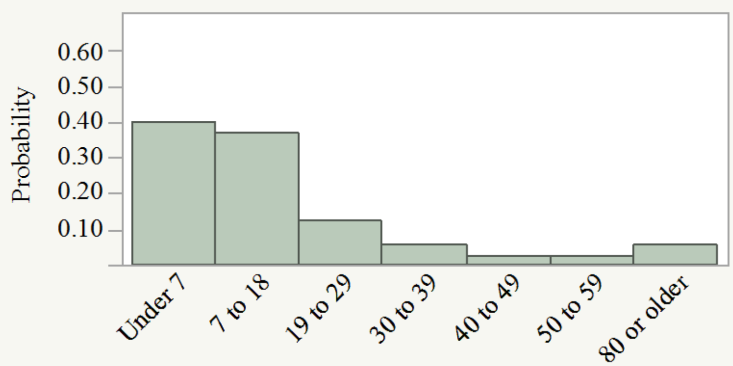


Frequencies

Level	Count	Prob
Employed	25	0.19380
Family Care Giver (not employed outside own home)	5	0.03876
Student	78	0.60465
Presently Unemployed	7	0.05426
Retired	5	0.03876
Not Applicable	9	0.06977
Total	129	1.00000

N Missing 1542
6 Levels

Person 6 age

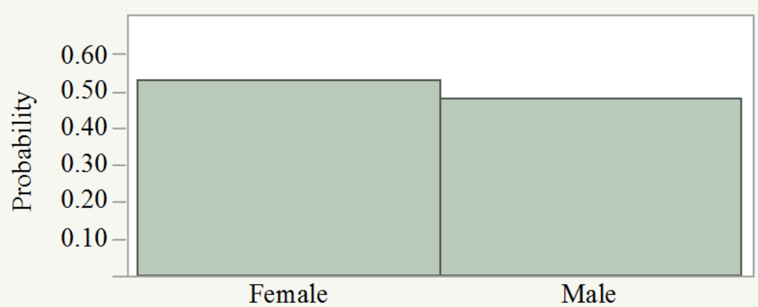


Frequencies

Level	Count	Prob
Under 7	24	0.39344
7 to 18	22	0.36066
19 to 29	7	0.11475
30 to 39	3	0.04918
40 to 49	1	0.01639
50 to 59	1	0.01639
80 or older	3	0.04918
Total	61	1.00000

N Missing 1610
7 Levels

Person 6 gender

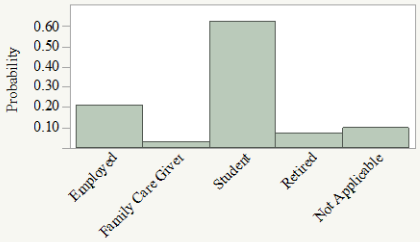


Frequencies

Level	Count	Prob
Female	32	0.52459
Male	29	0.47541
Total	61	1.00000

N Missing 1610
2 Levels

Person 6 work status

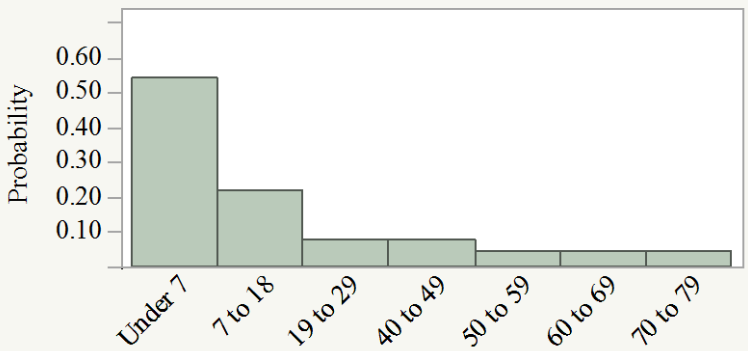


Frequencies

Level	Count	Prob
Employed	9	0.20455
Family Care Giver (not employed outside own home)	1	0.02273
Student	27	0.61364
Retired	3	0.06818
Not Applicable	4	0.09091
Total	44	1.00000

N Missing 1627
5 Levels

Person 7 age

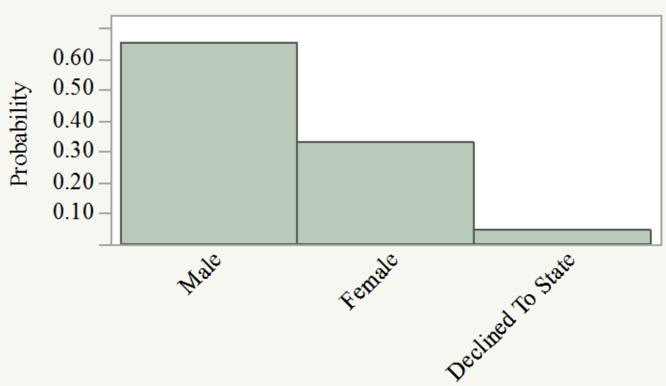


Frequencies

Level	Count	Prob
Under 7	15	0.53571
7 to 18	6	0.21429
19 to 29	2	0.07143
40 to 49	2	0.07143
50 to 59	1	0.03571
60 to 69	1	0.03571
70 to 79	1	0.03571
Total	28	1.00000

N Missing 1643
7 Levels

Person 7 gender

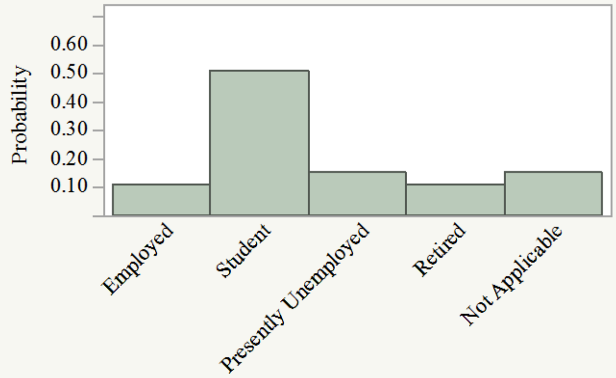


Frequencies

Level	Count	Prob
Male	18	0.64286
Female	9	0.32143
Declined To State	1	0.03571
Total	28	1.00000

N Missing 1643
3 Levels

Person 7 work status

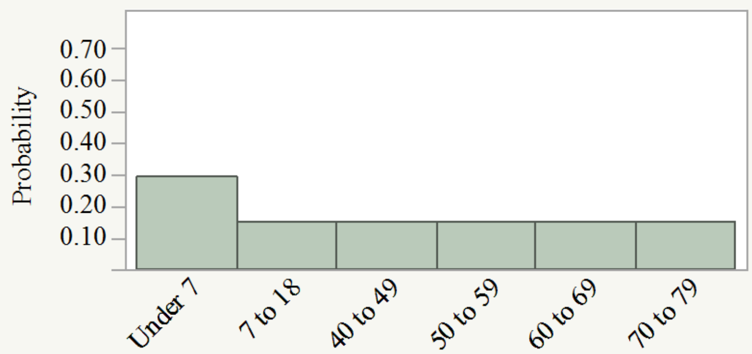


Frequencies

Level	Count	Prob
Employed	2	0.10000
Student	10	0.50000
Presently Unemployed	3	0.15000
Retired	2	0.10000
Not Applicable	3	0.15000
Total	20	1.00000

N Missing 1651
5 Levels

Person 8 age

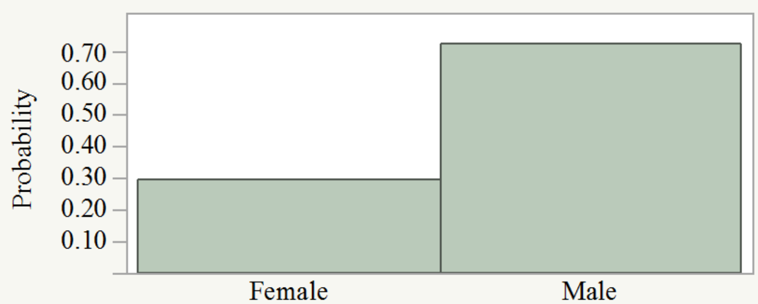


Frequencies

Level	Count	Prob
Under 7	2	0.28571
7 to 18	1	0.14286
40 to 49	1	0.14286
50 to 59	1	0.14286
60 to 69	1	0.14286
70 to 79	1	0.14286
Total	7	1.00000

N Missing 1664
6 Levels

Person 8 gender

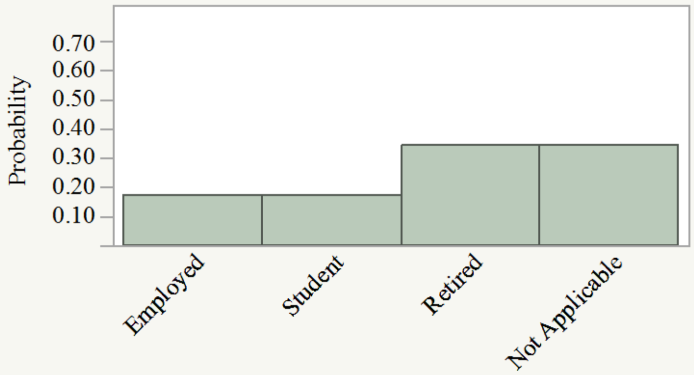


Frequencies

Level	Count	Prob
Female	2	0.28571
Male	5	0.71429
Total	7	1.00000

N Missing 1664
2 Levels

Person 8 work status



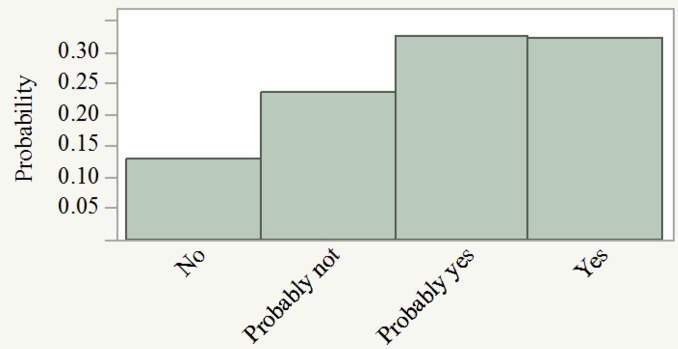
Frequencies

Level	Count	Prob
Employed	1	0.16667
Student	1	0.16667
Retired	2	0.33333
Not Applicable	2	0.33333
Total	6	1.00000

N Missing 1665
4 Levels

Is there someone in the household that friends and extended family would describe as being very interested in new technology and is often among the first people to buy a product specifically because it uses new technology.

Technophile at home



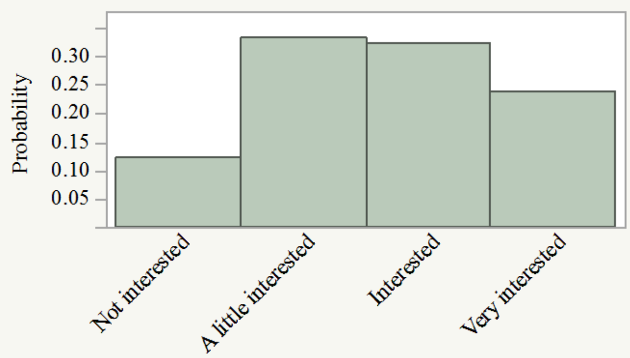
Frequencies

Level	Count	Prob
No	208	0.12448
Probably not	390	0.23339
Probably yes	538	0.32196
Yes	535	0.32017
Total	1671	1.00000

N Missing 0
4 Levels

Respondent's interest in technical details of vehicles that run on electricity or hydrogen.

Personal interest in ZEV tech



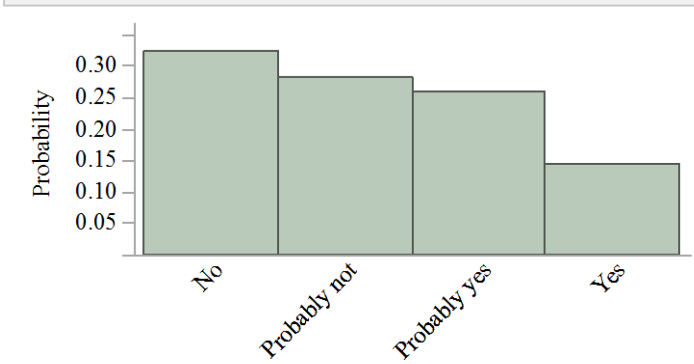
Frequencies

Level	Count	Prob
Not interested	197	0.11789
A little interested	551	0.32974
Interested	533	0.31897
Very interested	390	0.23339
Total	1671	1.00000

N Missing 0
4 Levels

Given the previous question, is there someone else in the household more interested than the respondent in the technical details of vehicles that run on electricity or hydrogen?

More interest in home in ZEV tech

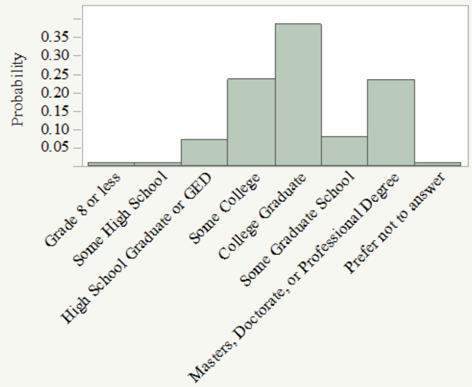


Frequencies

Level	Count	Prob
No	536	0.32077
Probably not	469	0.28067
Probably yes	431	0.25793
Yes	235	0.14063
Total	1671	1.00000

N Missing 0
4 Levels

Respondent Education

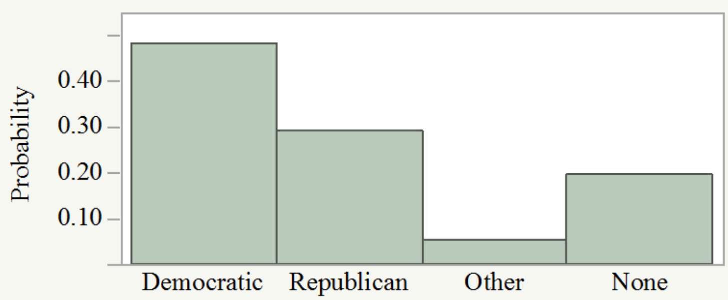


Frequencies

Level	Count	Prob
Grade 8 or less	6	0.00359
Some High School	7	0.00419
High School Graduate or GED	112	0.06703
Some College	389	0.23279
College Graduate	638	0.38181
Some Graduate School	129	0.07720
Masters, Doctorate, or Professional Degree	381	0.22801
Prefer not to answer	9	0.00539
Total	1671	1.00000

N Missing 0
8 Levels

2 party political affiliation

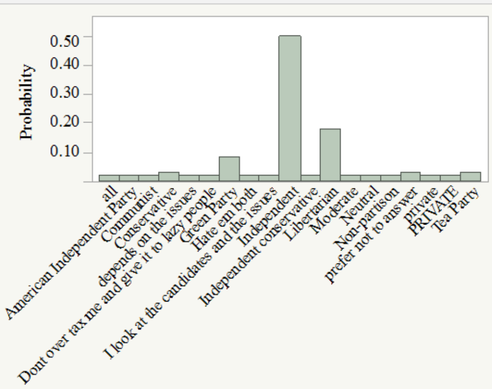


Frequencies

Level	Count	Prob
Democratic	799	0.47816
Republican	476	0.28486
Other	77	0.04608
None	319	0.19090
Total	1671	1.00000

N Missing 0
4 Levels

Other political affiliation



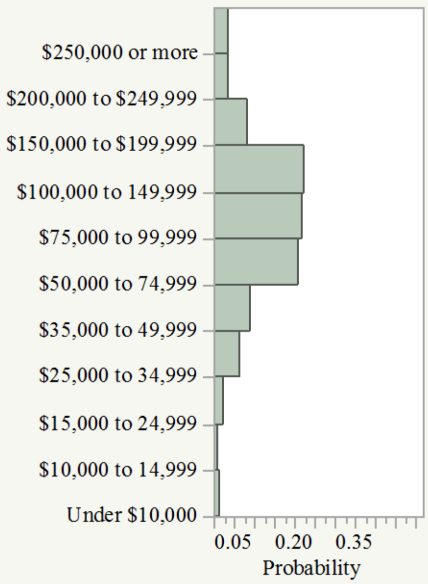
Frequencies

Level	Count	Prob
all	1	0.01333
American Independent Party	1	0.01333
Communist	1	0.01333
Conservative	2	0.02667
depends on the issues	1	0.01333
Dont over tax me and give it to lazy people	1	0.01333
Green Party	6	0.08000
Hate em both	1	0.01333
I look at the candidates and the issues	1	0.01333
Independent	37	0.49333
Independent conservative	1	0.01333
Libertarian	13	0.17333
Moderate	1	0.01333
Neutral	1	0.01333
Non-partison	1	0.01333
prefer not to answer	2	0.02667
private	1	0.01333
PRIVATE	1	0.01333
Tea Party	2	0.02667
Total	75	1.00000

N Missing 1596
19 Levels

Last year’s household income from all sources

Income



Quantiles

100.0%	maximum	11
99.5%		11
97.5%		11
90.0%		9
75.0%	quartile	8
50.0%	median	7
25.0%	quartile	6
10.0%		4
2.5%		2.8
0.5%		1
0.0%	minimum	1

Summary Statistics

Mean	6.8312388
Std Dev	1.9231351
Std Err Mean	0.0470459
Upper 95% Mean	6.9235139
Lower 95% Mean	6.7389637
N	1671

Summary of Open-ended Statements volunteered by respondents at the end of their survey responses

General

"Interesting Survey"

"Hydrogen should also be explored as a burned fuel to existing engines."

"I like the possibility of driving a alternative fuel vehicle."

"Natural gas has worked well for fleet vehicles: trucks and buses. The most sensible future is better car batteries so that cars can idle at traffic lights, etc. on battery power alone."

"I really liked the topic of this survey. These are issues I often think about but feel that there is not enough forum for me to be a part of the discussion."

"I think it would be great if you included a link to a website which compared the electric / hybrid cars on the market currently."

"I know that Tesla is coming out with a more affordable model in a few years. This is one I would be interested in."

"About 18 years ago, I answered a detailed survey from Stanford about the feasibility of having an electric car. Since then, I have read whatever I run across about them, but I am still not 'sold' because I sometimes drive into wilderness areas and could not take an electric car that far out. Too bad. Most of the time, it would be very nice. I detest going to gas stations, so charging up at home is kind of a nice alternative. I work in a school library where kids all just watched a program about the driverless car. I wonder how that technology plays into fuel alternatives. I am personally slow to adapt the latest technology, but my husband is a computer tech support person and is into gadgets. Decades ago, we were both archaeologists dependent on our cars, but living low tech lives camping on the job. I think rental car companies ought to pave the way for average citizens to get used to driving alternatively fueled vehicles."

"I think it's an absolute necessity to make the change from fossil fuels to other forms of power for vehicles. Oil companies are not invested in 'new' and would do anything to keep the status quo."

"I hope this helps put in motion the decisions to better the future of whoever seems to still have the dream to raise children with no worry of what happens after that."

"It's good to find new ways to make our world better."

"Electric, hybrid, and hydrogen vehicles are NOT right for me or anyone else. It's ridiculous and a waste and only a bunch of fools would consider driving one."

"Currently own hybrid. This household will not ever purchase such technology again. Vehicle was expensive to purchase and has been riddled with problems including 6 recalls. More importantly the mpg is no where near what it is supposed to get."

“When we purchase a new vehicle, my husband and I decide together, but he knows a lot more than I do about vehicles and shares his information with me. He has said many times that he would never buy an electric vehicle even though he knows people who have.”

Environment-Positive

“Save the earth with these vehicles.”

“It's time to change how we harm our environment and the people on the planet. Simple remedies will help if each person takes the step necessary.”

“Alternate fuel for our nation is imperative if we are to clean up our air. Keep up the good work. We need organizations like you.”

“I am so ready for this country to evolve! It's time to embrace and explore new technologies that minimize our impact on the earth. We are capable. I do believe certain information is being repressed to an extent. Primarily because some industries will cease to exist/ lose profits if this information gets out and people begin utilizing it. I would love to learn more about alternative fuel sources, and this survey has sparked my interest. I don't think this information is as widespread as it could be, and should be. A big thanks to those who are exploring, questioning and developing eco-friendly technologies & ways of living. Thank you to the pioneers at UC DAVIS and elsewhere.”

“Living green is so easy is so many different ways. Electric cars would make an impact almost immediately IF they are made affordable. I think what slows down production of electric vehicles is the oil companies don't want to lose all the gasoline profits.”

“I do hope the automobile companies head toward making better cars using safer fuels for the environment soon.”

“If we bought made is USA electric and Hybrid cars, we could quit investing so much money in foreign oil, and start fixing the pollution of our air and lands in our country!”

Environment-Negative

“There was no choice of diesel for the cars you wanted us to pick. I would always pick a diesel car over a gasoline, electric or hybrid car. Most electricity in this country comes from coal powered plants - dirty stuff. Batteries are made with lead and their manufacturing is a dirty process. Once the life of the batteries is over they become hazardous waste and must be disposed of but where? Diesel is cleaner than gasoline, coal and the processes needed for batteries.”

“Climate change? A big scam!!!!! We need to conserve energy but for the right reasons: #1, current resources will not last forever. #2, there are major health concerns with pollution in any form! The earth's climate HAS BEEN changing significantly and cyclically in its 4-1/2 billion year existence. And finally, ordinarily I would be tempted to be called back for further opinion, but I get the idea that UC Davis running this survey is just another leftist school. Both of us are

UC trained (other campuses) and do not pitch in one thin dime in alumni giving thanks to some of the most radical (and inhumane) ideas being preached at those very institutions. Good Night! Yes, and Merry CHRISTMAS!"

"My concerns about all-electric vehicles are that the pollution created by the generation of electricity may be far greater than the pollution generated by high-efficiency automobiles. Generating electricity for vehicles at coal-fired power plants is highly inefficient and polluting compared to using an efficient hybrid vehicle."

"Major concern with electric is eventual disposal of batteries..."

"Solar power won't be widespread until they figure out how to put a meter on the sun and charge us for the power. Paying upfront for gas or electricity is not the way to get people to cooperate. Few people care that much about saving the planet to spend more on a car."

"The environmentalist have an enormous amount of NOT NEEDED influence over what we should be able to choose to select and enjoy!!!!FREEDOM and INDEPENDENCE!!!!"

Lack of Knowledge

"At this point, I'm not sure how I feel about the new vehicles. The last time I checked I was shopping for a new vehicle, I learned the cost of replacing the battery for the Prius was about half the cost of the vehicle itself and it was only good for like 6 years! I think there is much information in promotion literature that leaves that kind of information out. I'm more interested in seeing how it works, test stats for reliability for long distance trips. I frequently drive two days or more alone to see my grand kids. I want to know that I will make it and make it safely. Easy access to recharge or refuel and NO holdups in sketchy neighborhoods. I feel that planned obsolescence is how most product in the marketplace are designed today. If someone gave me one? Sure, I'd test it out and give you amazing feedback!"

"I haven't been educated enough on the benefits of electric or hydrogen vehicles.

"I would not know where to start."

"Are there hydrogen on the market right now? I thought it was in testing phase. A bit confused on that part. Electric cars are great thus far like the Prius and I can't wait for the smaller Telsa [sic] to come out."

"The survey did bring to attention my lack of knowledge on alternate fuel sources for autos. Hopefully, I will become better educated."

"For the average person it's difficult to navigate through all the benefits vs. cost vs. impact, etc. Buying an alternative fuel vehicle honestly feels out of reach."

Prices, Costs, Financial Incentives

"I'm interested in electric and hydrogen cars but the price would have to come down to the gas car price."

“I am a strong proponent of electric vehicles. My biggest concern is the cost of the new vehicle when compared to existing gasoline vehicles. For the limited driving I do, the cost savings from not purchasing gasoline and reduced maintenance do not make sense when compared to a gasoline vehicle. However, I am hoping in the next 3-5 years that costs of electric vehicles will be reduced such that the break-even point will be 5 years or less. Note, I am willing to pay more for an all-electric vehicle even if there is no near-term break-even point. However, the cost differential can't be too large.”

“Electric vehicles and plugin hybrid vehicles are on the right path but more higher incentives should be made to justify cost.”

“I will be retiring within the next two years and my mileage will be reduced by at least half, so the cost of a vehicle is more important that the cost of fuel.”

“Price is the key.”

“Bring cost of purchase of electric/hybrid cars closer to that of gasoline-powered, then many more people including me will buy them. Right now, savings on electricity vs. gasoline take years to make up for increased purchase price.”

“After looking at all the costs and incentives, I do not feel that electric cars are worth the time or effort. Apparently, in addition to the EXTRA $2,000 cost for an electric KIA you have to install a HOME CHARGER costing $7,500 and THEN PAY MORE FOR ELECTRICITY to charge your vehicle no matter WHERE you charge it. Not to mention, the horrible driving habits (and dangerous) of hybrid or electric car drivers. I've heard people call driving them "A game, to see how little gas/electricity you use while driving" apparently forgetting there are other vehicles on the road. Not only that, but there are HUGE DIESEL TRUCKS EVERYWHERE THAT SPEW 100 TIMES THE AMOUNT OF POLLUTION SMALLER CARS DO. WHAT GOOD IS DRIVING A HYBRID WHEN EASILY OVER 500,000 DIESEL TRUCKS POLLUTE 1000'S OF TIMES THE POLLUTION? Get rid of the trucks OR MAKE DIESEL TRUCKS HYBRID. It's ridiculous and gimmicky to sell environmental contradictions like that.”

“I know someone who has Chevy Volt he says electricity costs went up quite a bit no mention of increased electricity usage, costs etc. in survey.”

“While I know all-electric vehicles are good for the environment, I've been iffy about them for a variety of reasons. However, I recently learned that my mechanic and his family have been driving a Fiat 500e for about 6 months and they are extremely impressed with it. I spoke with them about the costs and operation of the vehicle, that it basically needs no maintenance, and all of the incentives offered by the manufacturer and government. Based on their experience, I am much more interested in an electric vehicle now. Also, if I lived in a multi-car family, I would probably already have a hybrid, NGV or EV right now.”

Anti-government, Policy

"Even though I am not aligned with either the Democratic or Republican parties, the current Obama administration sickens me to death and most of my friends/family feel similarly."

"Keep government out of our lives."

"If electric cars were a good and practical idea, the marketplace would demand it and effectively underwrite its development. Government imposition of electric car standards would inevitably collapse because the car industry, and destroy our economy."

"This survey is so politically biased it's ridiculous. Of course with the survey coming from a Marxist, left wing institution like UC Davis it should be no surprise."

Not enough PEV chargers

"Electric vehicles have very few charging stations in my area; actually I know of none available to the public. Hydrogen vehicles have the same issue with no known fueling stations that are available to the public and if I were to get an all electric vehicle wherever I go to visit someone, considering how spread out my area is, if I go visit them I'd have to clear ahead of time with them that I could plug in my vehicle to charge while I'm there. I don't know of anyone who has an electric vehicle charging station to do so, so this would not be a feasible option."

"My main concern about alternate fuels is the availability in my area. I live in a rural area (zip code: 93527) and there aren't any fuel places that I am aware of. The closest town that might have fuel available is Lancaster, which is ~80 miles away."

"I would love to go electric, but I drive to San Francisco occasionally and a plug in hybrid would not make it and the fuel cell vehicle that would is very expensive. Until they start putting up more charging stations my next car will be a hybrid."

"It really is something that is needed, but until you can make it convenient for fueling I believe it won't catch on very well. Once it is easy, then it will go over quite well. Kind of like how in the beginning of gas powered cars, when it wasn't easily available not many people had cars. Once it became easier, many people had them. That takes quick fueling stations being readily available and a car being able to travel distances that are realistic. Many commuters put on as much as 120+ miles per day. Less than that is useless."

"I think it is unfortunate that there isn't a network of hydrogen fueling stations. This technology, in my opinion, is the most promising. The vehicles only emit water and safety is in the same range as CNG which has been available for decades."

No access to PEV charger at home

"I don't mean to come off as unconcerned about the environment. It's just that I am unable to purchase a home in Los Angeles due to the high cost of housing. Every apartment complex I have ever lived at has not provided a charging station for electric vehicles."

"Higher density housing should be required to make charging stations available. The lack of this requirement makes it likely I will not be able to purchase an EV or PHEV even though there is an electrical outlet right at my garage parking space. I live in a condo building governed by an HOA."

"I would have answered differently if it were possible to be able to charge my car at home. The complex where I live does not permit individual electric outlets."

Other Objections

"I am aware many see EVs as the savior of our transportation. In urban areas, quite possibly yes. In rural areas not so much. Extreme rural areas, not at all. Then there is cost, both the vehicle and the electricity to recharge them. This also could have a factor on the environment. In reality these vehicles are an energy shift. From oil to electricity. Many if not most of our generating facilities are yet to be run by clean fuels. In all probability this may never change. Increasing demand increases pollution from these. Present 'Green' technologies don't even come close to being able to provide our needs. So, one has to ask, where does all of this energy to recharge these vehicles come from? To add to the idiocy of this at present there is a serious move to remove 4 Hydro-electric generating dams on the Klamath River here in No. CA and So. OR. Climate Change, hey, they finally got it right! It has been changing since the planet began. And, will continue to do so until the place ceases to exist. Do we have an effect on this? Probably, if from nothing other than our sheer numbers, and the heat we our selves generate."

APPENDIX F: ANNOTATED SCREENSHOTS OF ON-LINE QUESTIONNAIRE

This appendix illustrates the on-line questionnaire, in general, in a series of screen captures. Because of extensive customization during the course of any individual response, there are as many different versions of “the” questionnaire as there are people who take it. Customization affects which questions respondents see, for some questions which answers are shown, which design games respondents play, which drivetrain design options they see within any design game, which prices are assigned to the design options they see, and which incentives they are offered for a given design. Annotations have been provided in this appendix to indicate where customization occurs.

Section 1: Your Household Vehicles

Note: Your "household" includes all the adults with whom you currently live and jointly make financial decisions such as vehicle purchases, and any of your children living with you. If you live alone, then you are your household.

*** How many vehicles does your household currently own or lease, that are driven at least once per week? *(Count cars, trucks, vans, minivans, or sport utility vehicles, but do not include motorcycles, recreational vehicles, or motor homes.)*** Q1a

Choose one of the following answers

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4 or more

*

Of these, how many did your household buy or lease as a *used* vehicle since January 2008?

Q1f

Choose one of the following answers

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4 or more
- ○ I'm not sure, but at least 1

*

Of these, how many did your household buy or lease as a *new* vehicle since January 2008?

Q1b

Choose one of the following answers

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4 or more
- ○ I'm not sure, but at least 1

Section 1: Your Household Vehicles

*

To the best of your recollection, when did your household most recently acquire a new vehicle?

Q1c

Month [ ] **Year** [ ]

2%

Section 1: First Vehicle

Of the vehicles that your household acquired as a new vehicle since January 2009, please enter the model year, make, and model of the one your household most recently acquired.

Example:
Year = 2011
Make = Honda
Model = Accord

Q2a

Year

Make

Model

Hover over common abbreviations for their meaning:
A, M, cyl, dr, L, CVT, AWD, 4WD, SUV

Option

Enter Manually

Did you buy or lease this vehicle?

Q3a1

Choose one of the following answers

This question is mandatory. If you choose 'Other, please describe:' please also specify your choice in the accompanying text field.

Bought

Leased

Neither, it was a gift

Other, please describe:

What was the total price including options, fees, and taxes of your ? If you're not sure, please give your best estimate. Round off to the nearest $500.

Q3a2

Only numbers may be entered in these fields.
Each answer must be between 0 and 999500

Price $ xxx,xxx

Click here if you have no idea

How is your fueled? *(Please check all that apply.)*

Q4a

Check any that apply

This question is mandatory. Please check at least one item. If you choose 'Other, please describe:' please also specify your choice in the accompanying text field.

Gasoline

Diesel (including biodiesel)

Ethanol

Electricity

Natural Gas

Hydrogen

I don't know

Other, please describe:

Is this the vehicle you drive most often? Q5a

This question is mandatory.

Yes

No

4%

Section 1: Second Vehicle

Not including the vehicle you just described, please enter the model year, make, and model of the remaining household vehicle that is driven most often.
Example:
Year = 2009
Make = Ford
Model = F150

Q2b

Year

Make

Model

Hover over common abbreviations for their meaning:
A, M, cyl, dr, L, CVT, AWD, 4WD, SUV

Option

Enter Manually

*

Did you buy or lease this vehicle?

Q3b1

Choose one of the following answers

- Bought
- Leased
- Neither, it was a gift
- Other, please describe:

What was the total price including options, fees, and taxes of your ? If you're not sure, please give your best estimate. Round off to the nearest $500.

Q3b2

Only numbers may be entered in these fields.
Each answer must be between 0 and 999500

Price $ xxx,x00

- Click here if you have no idea

*

How is your fueled? *(Please check all that apply.)*

Q4b

Check any that apply

- Gasoline
- Diesel (including biodiesel)
- Ethanol
- Electricity
- Natural Gas
- Hydrogen
- I don't know
- Other (Please specify):

6%

Section 1: Vehicle Choice

*

Of the vehicles you just described, which one do you personally drive most often? Select one only.

Q5

Choose one of the following answers

The descriptions provided of Vehicle 1 and Vehicle 2 (if it exists) are displayed. This question determines the vehicle about which subsequent questions are asked, i.e., the vehicle the respondent drives most often.

10%

Section 1: Gasoline / Diesel / Ethanol

If you know your fuel economy, that is, your miles per gallon (mpg) for your please enter it below. *Choose a number that you think is your average of city and highway driving.*

Q6a

> This is the first of a set of questions distinguished by fuel type of the vehicle the respondent drives most often. Based on prior question about how the vehicle is fueled, respondents see only the set of questions that applies to their vehicle.

Only numbers may be entered in these fields.

Fuel Economy xxx.x MPG

☐ Click here if you have no idea

How far is your driven per week or per month?

Q7a

Miles xxxx **per**

On average, how much does your household spend on fuel for your per week or per month?

Q8a

Amount $ xxx **per**

* **How accurate are your estimates for how much your household spends on fuel for your ?** Q9a

Choose one of the following answers

- ○ Highly accurate; I know exactly how much we spend
- ○ Accurate; I might be off by 10%
- ○ Sort of accurate; I might be off by 25%
- ○ Not very accurate; I might be off by 50% or more
- ○ I have no idea what we spend

12%

Section 1: Electric

If you know your fuel economy, that is, your miles per gallon gasoline equivalent (mpgge) or your average kWh per mile for your please enter it below. *Choose a number that you think is your average of city and highway driving.*

Q6b

Only numbers may be entered in these fields.

xxx.: mpgge

xxx.: kWh per mile

☐ Click here if you have no idea

How far is your driven per week or per month?

Q7b

Miles xxxx **per**

On average, how much does your household spend on electricity for your per week or per month?

Q8b

Amount $ xxx **per**

How much charging of your has been free?

Grab the red slider at the far right and move it to the point on the scale that matches your answer.

Q8b1

None | All | I'm unsure | **No answer**

*

How accurate do you think your estimates are for how much your household spends on electricity for your ?

Q9b

Choose one of the following answers

- Highly accurate; I know exactly how much we spend.
- Accurate; I may be off by 10%.
- Sort of accurate; I may be off by 25%.
- Not very accurate; I may be off by 50% or more.
- I have no idea what we spend.

14%

Section 1: Plug-in Hybrid

If you know your fuel economy, that is, your miles per gallon gasoline equivalent (mpgge) for your please enter it below. *Choose a number that you think is your average of city and highway driving.*

Q6c

Only numbers may be entered in these fields.

Fuel Economy xx. MPGGE

☐ Click here if you have no idea

How far is your driven per week or per month?

Q7c

Miles xxxx **per**

Including both gasoline and electricity, on average, how much does your household spend to "fuel" your with electricity and gasoline per week or per month?

Q8c

Amount $ xxx **per**

How much charging of your has been free?

Grab the red slider at the far right and move it to the point on the scale that matches your answer.

Q8c1

None All I'm unsure **No answer**

*** How accurate do you think your estimates are for your household's combined spending on gasoline and electricity for your ?** Q9c

Choose one of the following answers

- Highly accurate; I know exactly how much we spend
- Accurate; I might be off by 10%
- Sort of accurate; I might be off by 25%
- Not very accurate; I might be off by 50% or more
- I have no idea what we spend

16%

Section 1: Natural Gas

If you know your fuel economy, that is, your miles per gallon gasoline equivalent (mpgge) for your please enter it below. *Choose a number that you think is your average of city and highway driving.*

Q6d

Only numbers may be entered in these fields.

Fuel Economy xx. MPGGE

☐ Click here if you have no idea

What was the price of natural gas the last time your was fueled? *Please give your best estimate.*

Q7d

Only numbers may be entered in these fields.
Each answer must be between 0 and 999500

Price $ x.xx per gallon gasoline equivalent

☐ Click here if you have no idea

On average, how much does your household spend on natural gas for your per week or per month?

Q8d

Amount $ xxx **per**

* **How accurate do you think your estimates are for how much your household spends on natural gas for your ?** Q9d

Choose one of the following answers

- ○ Highly accurate; I know exactly how much we spend
- ○ Accurate; I might be off by 10%
- ○ Sort of accurate; I might be off by 25%
- ○ Not very accurate; I might be off by 50% or more
- ○ I have no idea what we spend

18%

Section 1: Hydrogen

If you know your fuel efficiency, that is, your miles per gallon gasoline equivalent (mpgge) for your please enter it below. *Choose a number that you think is your average of city and highway driving.*

Q6e

Only numbers may be entered in these fields.

Fuel Efficiency xx. MPGGE

☐ Click here if you have no idea

What was the price of hydrogen the last time your was fueled? *Please give your best estimate.*

Q7e

Only numbers may be entered in these fields.
Each answer must be between 0 and 999500

Price $ x.xx per gallon gasoline equivalent

☐ Click here if you have no idea

On average, how much does your household spend on hydrogen for your per week or per month?

Q8e

Amount $ xxx **per**

* **How accurate do you think your estimates are for how much your household spends on hydrogen for your ?** Q9e

Choose one of the following answers

- ○ Highly accurate; I know exactly how much we spend
- ○ Accurate; I might be off by 10%
- ○ Sort of accurate; I might be off by 25%
- ○ Not very accurate; I might be off by 50% or more
- ○ I have no idea what we spend

20%

Section 1: Cost of Fuel

Statement is customized based on the number of vehicles.

You've told us your household has vehicles it drives at least once a week. On average, how much does your household spend in total for all fuels for all these vehicles? *Please give your best estimate. Enter amount per week or per month.*

Q10

Amount $ x,xxx **per**

Options are "week" or "month."

* **How accurate do you think your estimates are for how much your household spends to fuel the vehicles it drives at least once per week?** Q11

Choose one of the following answers

- Highly accurate; I know exactly how much we spend.
- Accurate; I may be off by 10%.
- Sort of accurate; I may be off by 25%.
- Not very accurate; I may be off by 50% or more.
- I have no idea what we spend.

22%

Section 1: Replacement Fuels

*** If for any reason we could no longer use gasoline and diesel to fuel our vehicles, what do you think would likely replace them? *Choose up to three.*** Q12

- ☐ Bio-Diesel
- ☐ Ethanol
- ☐ Electricity
- ☐ Hydrogen
- ☐ Natural Gas
- ☐ Propane
- ☐ Other: ________
- ☐ None
- ☐ I have no idea

*** Of the likely replacements for gasoline and diesel you just selected, which one do you think is most likely? *Choose one answer.*** Q12A

If respondent selected any options (omitting "None" and "I have no idea") in the previous question, they are listed here as the available answers.

Section 1: Replacement Fuels 2

*

Which statement best explains why you chose as a likely replacement for gasoline and diesel? *Select only one reason.*

Q13

Choose one of the following answers

- ○ It is cheapest for drivers
- ○ It is safest for drivers
- ○ It is the best for the environment
- ○ It doesn't need to be imported from foreign countries
- ○ It has already proven to be effective
- ○ It will require the least amount of change for drivers and fuel providers
- ○ It is the most abundant in the United States
- ○ Other, please describe: ________

26%

Section 2: Daily Travel and Parking

* Which of the following best describes how much day-to-day flexibility your household has in who drives which vehicles? Q14

Choose one of the following answers

- I'm the only driver, so this question doesn't really apply to me
- Every day we decide who will drive the car or who will drive which car
- Each driver has their usual car, but *at least* once a week someone in the household will drive a different car
- Each driver has their usual car, but *less than* once a week someone in the household will drive a different car
- I have my car; they have their car. In general, we don't switch or swap

* In your day-to-day travel, do you drive on roads that have high occupancy lanes (also called HOV lanes, commuter lanes, or diamond lanes)? Q14A

Choose one of the following answers

- No
- Yes, however I am unable to use those lanes
- Yes, and I use those lanes

* In your day-to-day travel, do you drive on roads or bridges that have tolls? Q14B

Choose one of the following answers

- No
- Yes, and I pay those tolls
- Yes, however I have an exemption from paying at least some of the tolls or someone else pays them for me.

28%

Section 2: Page 2

*** Over the course of a seven-day week, how many days do you personally drive a car? Q16**

Choose one of the following answers

Please choose...

Available answers for this and the next question are zero to seven days.

*** Over the course of a seven-day week, how many days does anyone in your household drive a car? Q17**

Choose one of the following answers

Please choose...

*** Monday through Friday, do you personally tend to drive the same distance every day? Q18**

Choose one of the following answers

- The total distances I drive on weekdays are the same—no more than a mile or two difference between days.
- Total distances I drive on weekdays *vary* from two to ten miles a day
- Total distances I drive on weekdays *vary* from 11 to 20 miles a day
- Total distances I drive on weekdays *vary* by more than 20 miles

*** Do you commute to a workplace? Q19**

Choose one of the following answers

- Yes
- No

*** On how many of the days you commute to a workplace do you drive one of your household vehicles at least part of the way to work? Q20**

Choose one of the following answers

- Every commute day
- Almost every commute day
- On half of my commute days
- Some of my commute days
- A few of my commute days
- Never

Asked only if answer to previous question is, "yes."

30%

Section 2: Page 3

*** At home, where have you usually parked your over the last year?** Q21a

Choose one of the following answers

- Garage (attached to your home or freestanding)
- Carport (Covered, but not fully enclosed)
- Driveway (Not Covered)
- On the Street
- Parking Lot - Unassigned Space
- Parking Lot - Assigned Space
- Other: ____________

Placeholder for the name of whichever of Vehicle 1 or Vehicle 2 respondent drives most often. (This is always Vehicle 1 if the household has only one vehicle.)
Question is then repeated for the other of Vehicle 1 or 2, if the household owns more than one vehicle.

32%

Section 2: Page 4

*

Given where you park at home, could you reliably access any of the following to bring electricity to your vehicle? *Examples are shown on the right.*

Q22

Check any that apply

- [ ] A regular electrical outlet (110-volt). These are used for most home electrical appliances.

- [ ] A high power electrical outlet (220 to 240-volt). These are typically used for electric clothes dryers, electric stoves, electric furnaces and air conditioners.

- [ ] A device designed specifically for charging an electric vehicle.

- [ ] None of the above
- [ ] I don't know.

*

Does your household have the authority to install a new electrical outlet near one of your home parking spots? Or would you have to first get approval from another person or group?

Q23

Choose one of the following answers

- ◯ My household could make such an installation on its own authority.
- ◯ My household would need permission from some other person or group.

* **Do you have natural gas for heating, cooking, or your clothes dryer at your residence? (Don't count propane. Propane would be delivered by a truck and stored at your residence in a tank. Natural gas would be piped to your residence by your local gas utility company.)** Q24

Choose one of the following answers

- ◯ No, we don't have natural gas
- ◯ Yes, we do have natural gas

34%

Section 3: New Ways To Power Our Cars And Trucks

*

Are you familiar enough with these types of vehicles to make a decision about whether one would be right for your household?

Grab the red slider at the right and move it to the point on the scale that matches your answer.

Q27

Gasoline

No | Yes | I'm unsure | **No answer**

Electric

No | Yes | I'm unsure | **No answer**

Hybrid

No | Yes | I'm unsure | **No answer**

Plug-in Hybrid

No | Yes | I'm unsure | **No answer**

Fuel Cell

No | Yes | I'm unsure | **No answer**

*

Where you live, do you think powering a car with electricity poses less, similar, or more risk to the environment than powering it with gasoline?

Q29

Electricity poses *less* of a risk than gasoline | Electricity poses a similar risk to gasoline | Electricity poses *more* of a risk than gasoline | I'm unsure | **No answer**

*

What about the risk to human health?

Q29A

Electricity poses *less* of a risk than gasoline | Electricity poses a similar risk to gasoline | Electricity poses *more* of a risk than gasoline | I'm unsure | **No answer**

36%

Section 3: Page 2

*

Can you name an electric vehicle that is being sold in the US? Q30a

For each of these four naming questions, if the response is, "Yes" then they are provided text boxes to enter a manufacturer and model name.

No

Yes

*

Can you name a hybrid vehicle that is being sold in the US? Q30b

No

Yes

*

Can you name a plug-in hybrid vehicle that is being sold in the US? Q30c

No

Yes

*

Can you name a hydrogen fuel cell vehicle that is being sold in the US? Q30d

No

Yes

*

Have you seen any electric vehicle charging spots in the parking garages and lots you use? Q31

Choose one of the following answers

Yes. I've seen them at several places.

Yes. I've seen them at a few places.

Yes. I've seen them at one place.

No. I haven't seen any.

I'm not sure whether I've seen any or not.

How much driving experience do you have in these types of vehicles? Move the slider at right to point to the scale that describes your level of experience. Q32

Electric

None at all — Extensive driving experience — I'm unsure — **No answer**

Hybrid

None at all — Extensive driving experience — I'm unsure — **No answer**

Plug-in hybrid

None at all — Extensive driving experience — I'm unsure — **No answer**

Hydrogen fuel cell

None at all — Extensive driving experience — I'm unsure — **No answer**

38%

Section 3: Page 3

How much do you agree or disagree with each of the following statements about electric vehicles (cars and trucks powered only by batteries that must be plugged in to recharge)?

Please click the slider at the far right and move it to the point on the line that matches your answer along the scale of Strongly Disagree to Strongly Agree.

Q33

My household would be able to plug in a vehicle to charge at home

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

There are enough places to charge electric vehicles

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

It takes too long to charge electric vehicles

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

Electric vehicles do not travel far enough before needing to be charged

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

Electric vehicles cost more to buy than gasoline vehicles.

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

Gasoline powered cars are safer than electric vehicles.

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

Gasoline powered cars are more reliable than electric vehicles.

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

Section 3: Page 3

*

How much do you agree or disagree with each of the following statements about cars and trucks that are powered by a hydrogen fuel cell.

Please click the slider at the far right and move it to the point on the line that matches your answer along the scale of Strongly Disagree to Strongly Agree.

Q34

There are enough places for drivers to refuel their cars and trucks with hydrogen.

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

Hydrogen fuel cell vehicles take too long to refuel.

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

Hydrogen fuel cell vehicles do not travel far enough without needing to be refueled.

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

Hydrogen fuel cell vehicles cost more than gasoline cars.

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

Gasoline vehicles are safer than hydrogen fuel cell vehicles.

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

Gasoline vehicles are more reliable than hydrogen fuel cell vehicles.

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

40%

Section 3: Page 4

As far as you are aware, is each of the following offering incentives to consumers to buy and drive vehicles powered by alternatives to gasoline and diesel? *Please respond to all.*

Q36

	Yes	No	I'm Not Sure
The federal government	○	○	○
State governments	○	○	○
City governments	○	○	○
Air quality districts or other regional government agencies	○	○	○
Electric utilities	○	○	○
Vehicle manufacturers	○	○	○
Vehicle dealerships	○	○	○
Oil companies	○	○	○
Other businesses	○	○	○

42%

Section 3: Page 5

*

Should governments offer incentives to consumers to buy and drive vehicles that run on electricity or hydrogen?

Q37a

Choose one of the following answers

- ○ Yes, but only electricity
- ○ Yes, but only hydrogen
- ○ Yes, both electricity and hydrogen
- ○ No, neither one
- ○ I'm not sure

44%

Section 3: Page 6

How much was your households' last electricity bill? (Exclude natural gas if you pay for both natural gas and electricity on the same bill.) *Round to the nearest dollar*.

Q38

Choose one of the following answers

- My household paid $ xxx.xx for our last electricity bill.
- We did not pay anything for electricity. Please explain:

*** How did you know the above answer about your electricity bill?** Q39

Choose one of the following answers

- I knew this off the top of my head.
- I had to look at the bill or ask someone in our household.
- I made a rough guess.

46%

Section 4: Designing Your New Vehicle

*

Electric vehicles (EVs) run only on electricity; they plug-in to charge their batteries.

Plug-in hybrid electric vehicles (PHEVs) run on electricity and gasoline; you can both plug them in to charge their batteries and refuel them at a gasoline station.

Have you considered buying either of these types of vehicle for your household? *Select one answer.*

Q40

Choose one of the following answers

- I (we) have not—and would not—consider buying a vehicle that runs on electricity
- I (we) have not considered buying a vehicle that runs on electricity—but maybe some day we will
- The idea has occurred, but no real steps have been taken to shop for one
- Started to gather some information, but haven't really gotten serious yet
- Shopped for an electric vehicle, including a visit to at least one dealership to test drive
- I (we) already have a vehicle powered by electricity

* **Have you considered buying a vehicle powered by hydrogen for your household? *Select one only that best describes your level of consideration.*** Q41

Choose one of the following answers

- I (we) have not—and would not—consider buying a vehicle that runs on hydrogen
- I (we) have not considered buying a vehicle that runs on hydrogen—but maybe some day we will
- The idea has occurred, but no real steps have been taken to shop for one
- Started to gather some information, but haven't really gotten serious yet
- Shopped for a hydrogen vehicle, including a visit to at least one dealership to test drive
- I (we) already have a vehicle powered by hydrogen

For both these questions, if the response is "Shopped for..." then follow up questions ask whether they have made a decision as to whether to buy a vehicle that runs on electricity (or hydrogen) and if they have decided against, there is an open ended-follow up as to why.

48%

Section 4: Page 2

The next few questions are about the next new car or truck your household will buy or lease. Even if you are not sure what your household will do next about your next new vehicle, please provide an answer that is plausible for your household.

* Which statement best summarizes your household's plans for its next new vehicle? Q42

Choose one of the following answers

- Already picked out our next new vehicle
- Discussed a few different vehicles, but have not made a decision yet
- Haven't really thought about it at all
- Don't plan on buying another new vehicle

Section 4: Page 2

* How soon do you believe your household will buy or lease its next new vehicle? Q43

Choose one of the following answers

- Within the next 6 months
- Between 6 months and 1 year from now
- Between 1 and 2 years from now
- Between 2 and 5 years from now
- More than 5 years from now
- No idea really

Section 4: Page 2

* Which is most likely regarding the purchase of your household's next new vehicle? Q44

Choose one of the following answers

- Will replace our
- Will replace our
- The next new vehicle would replace another existing household vehicle
- The next new vehicle would not replace an existing vehicle; it would be added to the vehicles I (we) already have.
- I don't know

51%

Section 4: Page 3

*

We'd like to use a specific make and model for your vehicle design game. Please select a make and model that best represents a likely next new vehicle for your household. If you don't plan on ever getting another new vehicle or if you are really unsure what your next new vehicle might be, you can select to re-design your

A good vehicle to represent our possible next new vehicle is a:

car1

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Make

Model

Start Over

Enter Manually

About how much do you think your household would have to spend to buy a new ? Round off to the nearest $500.

msrp1

Only numbers may be entered in these fields.

$ xxx,xoo

☐ I really don't know how much we will spend

*

What do you think will be the approximate fuel economy (Miles Per Gallon – mpg) of this vehicle?

mpg1

Choose one of the following answers

- ○ 20 mpg (about average for all new trucks)
- ○ 27 mpg (about average for all new cars)
- ○ mpg (about average for a 2014)
- ○ Our next vehicle will run on electricity or hydrogen

53%

Section 4: Page 4

This brief guide outlines some of the vehicle options that will be offered to you. Some are available in cars and trucks you can buy or lease today, others are not yet available. For now, assume that you could buy or lease any of the vehicles you design.

Vehicle Type	Fuel or Charge?	Brief Description
Gasoline	Fuel with gasoline.	Similar to the gasoline vehicles on the road today.
Hybrid (HEV)	Fuel with gasoline.	An electric motor and battery assist the gasoline engine, producing either higher fuel economy, faster acceleration, or both. The battery does not plug in to charge.
Electric Vehicle (EV)	Charge with electricity	An electric motor and battery provide all the energy for driving. Options for distance between charging are from 60 to 300 miles. The battery charges by plugging into an electrical outlet or charging station. Charging time varies from a half-hour to several hours.
Plug-in Hybrid Electric Vehicle (PHEV)	Fuel with gasoline and charge with electricity	Includes an electric motor and gasoline engine. The vehicle uses electricity stored in a battery for 10 to 80 miles. Then, the vehicle switches to gasoline. The battery of a PHEV must be charged by plugging into an electrical outlet or charging station.
Fuel Cell Vehicle (FCV)	Fuel with hydrogen	An electric motor powers the car; an on-board fuel cell makes the electricity using hydrogen. Available driving ranges between fueling with hydrogen vary from 150 to 350 miles. An FCV can be refueled in a few minutes at a refueling station or at home overnight with an optional appliance.

More Information

When making your vehicle designs, you may find you want more information. The link below will open a description of HEVs, PHEVs, and EVs written by the US Department of Energy in a new window:
http://www.afdc.energy.gov/uploads/publication/hybrid_plugin_ev.pdf

More information about FCVs is available here (this will also open in a new window):
http://www.nrel.gov/docs/fy11osti/49018.pdf

info1a

55%

Section 4: Page 5

Okay! Now you're ready to design your new vehicle. You will be shown two or three scenarios depending on the vehicles you design.

Other than the prices and specific electric, plug-in hybrid, or hydrogen fuel cell performance features presented to you, assume everything else about all the vehicle types are identical to the gasoline or diesel versions. For example, an electric has the same body, interior size, amenities and other options as the gasoline .

Many people finance their vehicle purchases, or lease instead of buying. Because so many things affect financing and lease costs, we can't accurately estimate monthly payments. We only show you an estimate of the total initial price of the vehicles you design.

57%

Section 4: Page 6

All-Body Styles Scenario

As you explore, you can see the effect of different designs on the total purchase price at the bottom of each column. When you've designed a vehicle that matches your wishes and your budget, confirm your selection by checking the box at the bottom in the column of the vehicle you want.

Game1

Gasoline	Hybrid	Plug-in Hybrid	Electric	Hydrogen Fuel Cell
	Electric mode: None; fuel mode only. Some hybrids will drive short distances using only electricity, but as a practical matter not far enough to complete trips without using gasoline.	**Electric mode:** Pick both A) type of electric mode and B) distance electric mode lasts. A. Type of electric mode *Assist:* combination of gasoline and electricity provides energy use that is equivalent to 40 miles per gallon of gasoline, or 40 MPGe *All electric:* no gasoline -- select a mode -- B. Electric mode lasts for: -- select a range -- To stay in electric mode, you must charge the battery. Beyond your chosen distance, the vehicle switches to fuel mode (see below).	**Electric mode:** All electric, all the time. For how many miles before charging: -- select a range --	**Electric mode:** All hydrogen (thus all electric), all the time For how many miles before refueling: -- select a range --
Fuel mode: 12345 miles per gallon	**Fuel mode:** 17283 miles per gallon	**Fuel mode:** 17283 miles per gallon	**Fuel mode:** None; uses electricity only.	**Fuel mode:** 17283 miles per kilogram One kilogram of hydrogen is roughly equivalent to one gallon of gasoline.
Fueling: 5 to 10 minutes to fill tank at a service station	**Fueling:** 5 to 10 minutes to fill tank at a service station	**Fueling:** 5 to 10 minutes to fill tank at a service station **Charging:** Please indicate electric mode and range above before charging information ca shown.	**Charging:** Please indicate electric range above before charging information can be shown.	**Fueling:** 5 to 15 minutes to fill tank at a service station. Longer driving range options (offered below) will take a little longer. At first, there will only be a few places you can refuel with hydrogen. Imagine there is one hydrogen station that you can use to accomplish your day-to-day local travel. It is not the most convenient location -- it requires you to go a little bit out of your way. Out-of-town trips may or may not be possible. Imagine that for at least a couple years, there will be some out of town trips you can't make in your hydrogen fuel cell vehicle. Also, you may refuel *overnight at home* if you choose the optional home fueling appliance offered below.

Electric mode options plug-in hybrid, electric, and hydrogen fuel cell vehicles are shown in Table 1 of the main text.

Fuel mode mpg shown here are placeholders. Actual values shown depend on their base vehicle determined by the questions at Section 4, pp. 2-3.

Charging options for PEVs depend on the electric mode selections above. Three different times to charge are shown to respondents; those times vary by the electric mode selections. Faster charging is priced higher (Table 2 of main text).

Design exercise continues on the next page. These two pages are shown to respondents as a single screen.

Fueling: 5 to 10 minutes to fill tank at a service station	**Fueling:** 5 to 10 minutes to fill tank at a service station	**Fueling:** 5 to 10 minutes to fill tank at a service station **Charging:** Please indicate electric mode and range above before charging information can be shown.	**Charging:** Please indicate electric range above before charging information can be shown.	**Fueling:** 5 to 15 minutes to fill tank at a service station. Longer driving range options (offered below) will take a little longer. At first, there will only be a few places you can refuel with hydrogen. Imagine there is one hydrogen station that you can use to accomplish your day-to-day local travel. It is not the most convenient location -- it requires you to go a little bit out of your way. Out-of-town trips may or may not be possible. Imagine that for at least a couple years, there will be some out of town trips you can't make in your hydrogen fuel cell vehicle. Also, you may refuel *overnight at home* if you choose the optional home fueling appliance offered below.
		Please indicate electric mode and range above before upgrade information can be shown.	Please indicate electric range above before charging information can be shown.	**Home Fueling Option:** Requires a licensed plumber and electrician to install. You must have a place at home where you have the authority to make such an installation and a place close by to park your fuel cell vehicle over night. Overnight to refuel if your hydrogen tank is near empty when you start fueling. $7,500 (Installation included if you already have electricity nearby.) You previously indicated you can't reliably park a car at home within 50 feet of an electrical outlet.
Total: **$57321**	**Hybrid** Price: $57321 HEV: $1890 Total: **$59211**	**Plug-in Hybrid** Please indicate electric mode and range above before pricing information can be shown.	**Electric** Please indicate electric range above before charging information can be shown.	**Hydrogen Fuel Cell** Please indicate a fuel cell range above before pricing information can be shown.
I choose this one	I choose this one	I choose this one	I choose this one	I choose this one

Reminders such as this appear when respondent makes a home charging or fueling selection that contradicts previous answers about their home parking, electricity, and natural gas availability

Itemized price lists are shown here once respondent has selected electric mode and charging characteristics.

59%

Section 4: Page 7

You designed a full-size vehicle as . These body styles may not be available as electric vehicles or as plug-in hybrids with all electric operation for some time to come. You will have to reconsider your vehicle design.

info2

*

If your next new vehicle can't be , would you choose a smaller body style in order to get an electric vehicle or a plug-in hybrid with all-electric mode, or would you stick with a larger vehicle with a different power source?

Q45

Choose one of the following answers

- I'll stay with a larger vehicle, but give up having my next vehicle be .
- I'll switch to a smaller vehicle to keep .

Section 4: Page 7

* **Which of the following best describes the body type of this vehicle you will likely buy?** body2

Choose one of the following answers

- Compact car
- Mid-size car
- Large car
- Compact Truck
- Compact Van or Minivan
- Compact SUV
- I don't know

Section 4: Page 7

We'd like to use a specific make and model for your vehicle design game. Please select a make and model that best represents a likely next new vehicle for your household.

car2

POWERED BY edmunds.com

Make

Model

Start Over | Enter Manually

Section 4: Page 7

About how much do you think your household would have to spend to buy a new ? Round off to the nearest $500.

msrp2

Only numbers may be entered in these fields.

$ xxx,x00

☐ I really don't know how much we will spend

Section 4: Page 7

*

What do you think will be the approximate fuel economy (Miles Per Gallon – mpg) of this vehicle?

mpg2

Choose one of the following answers

- ○ 20 MPG (about average for all new trucks)
- ○ 27 MPG (about average for all new cars)
- ○ mpg (about average for a 2014)
- ○ Our next vehicle will run on electricity or hydrogen

61%

Section 4: Page 8

Second game is only played by people who design a full-size vehicle with battery-powered all-electric drive. For the second game they must choose to keep either full-size or battery-powered all-electric operation. This version is played by people who give up full-size. The full variety of electric mode options is available to them. All other notes from Game 1 regarding options and placeholders apply here.

No Trucks Scenario

As you explore, you can see the effect of diffe column. When you've designed a vehicle that checking the box at the bottom in the column

Game2

Gasoline	Hybrid	Plug-in Hybrid	Electric	Hydrogen Fuel Cell
	Electric mode: None; fuel mode only. Some hybrids will drive short distances using only electricity, but as a practical matter not far enough to complete trips without using gasoline.	**Electric mode:** Pick both A) type of electric mode and B) distance electric mode lasts. A. Type of electric mode *Assist:* combination of gasoline and electricity provides energy use that is equivalent to 40 miles per gallon of gasoline, or 40 MPGe *All electric:* no gasoline -- select a mode -- B. Electric mode lasts for: -- select a range -- To stay in electric mode, you must charge the battery. Beyond your chosen distance, the vehicle switches to fuel mode (see below).	**Electric mode:** All electric, all the time. For how many miles before charging: -- select a range --	**Electric mode:** All hydrogen (thus all electric), all the time For how many miles before refueling: -- select a range --
Fuel mode: 12345 miles per gallon	**Fuel mode:** 17283 miles per gallon	**Fuel mode:** 17283 miles per gallon	**Fuel mode:** None; uses electricity only.	**Fuel mode:** 17283 miles per kilogram One kilogram of hydrogen is roughly equivalent to one gallon of gasoline.
Fueling: 5 to 10 minutes to fill tank at a service station	**Fueling:** 5 to 10 minutes to fill tank at a service station	**Fueling:** 5 to 10 minutes to fill tank at a service station **Charging:** Please indicate electric mode and range above before charging information can be shown.	**Charging:** Please indicate electric range above before charging information can be shown.	**Fueling:** 5 to 15 minutes to fill tank at a service station. Longer driving range options (offered below) will take a little longer. At first, there will only be a few places you can refuel with hydrogen. Imagine there is one hydrogen station that you can use to accomplish your day-to-day local travel. It is not the most convenient location – it requires you to go a little bit out of your way. Out-of-town trips may or may not be possible. Imagine that for at least a couple years, there will be some out of town trips you can't make in your hydrogen fuel cell vehicle. Also, you may refuel *overnight at home* if you choose the optional home fueling appliance offered below.

Continuation of second design game, first version. All notes from first design game apply here.

Fueling: 5 to 10 minutes to fill tank at a service station	**Fueling:** 5 to 10 minutes to fill tank at a service station	**Fueling:** 5 to 10 minutes to fill tank at a service station **Charging:** Please indicate electric mode and range above before charging information can be shown.	**Charging:** Please indicate electric range above before charging information can be shown.	**Fueling:** 5 to 15 minutes to fill tank at a service station. Longer driving range options (offered below) will take a little longer. At first, there will only be a few places you can refuel with hydrogen. Imagine there is one hydrogen station that you can use to accomplish your day-to-day local travel. It is not the most convenient location -- it requires you to go a little bit out of your way. Out-of-town trips may or may not be possible. Imagine that for at least a couple years, there will be some out of town trips you can't make in your hydrogen fuel cell vehicle. Also, you may refuel *overnight at home* if you choose the optional home fueling appliance offered below.
		Please indicate electric mode and range above before upgrade information can be shown.	Please indicate electric range above before charging information can be shown.	**Home Fueling Option:** Requires a licensed plumber and electrician to install. You must have a place at home where you have the authority to make such an installation and a place close by to park your fuel cell vehicle over night. Overnight to refuel if your hydrogen tank is near empty when you start fueling. $7,500 (Installation included if you already have electricity nearby.) You previously indicated you can't reliably park a car at home within 50 feet of an electrical outlet.
Total: **$57321**	**Hybrid** Price: $57321 HEV: $1890 Total: **$59211**	**Plug-in Hybrid** Please indicate electric mode and range above before pricing information can be shown.	**Electric** Please indicate electric range above before charging information can be shown.	**Hydrogen Fuel Cell** Please indicate a fuel cell range above before pricing information can be shown.
I choose this one	I choose this one	I choose this one	I choose this one	I choose this one

Section 4: Page 9

Full-size Vehicle, No Electric Vehicle or Plug-in Hybrids with All-Electric Mode

To stay with a larger vehicle, you'll have to re-design it. Your available options are shown next.

Game2a

Gasoline	Hybrid	Plug-in Hybrid	Hydrogen Fuel Cell
	Electric mode: None; fuel mode only. Some hybrids will drive short distances using only electricity, but as a practical matter not far enough to complete trips without using gasoline.	**Electric mode:** Pick both A) type of electric mode and B) distance electric mode lasts. A. Type of electric mode *Assist:* combination of gasoline and electricity provides energy use that is equivalent to 40 miles per gallon of gasoline, or 40 MPGe *All electric:* no gasoline [Assist] B. Electric mode lasts for: [-- select a range --] To stay in electric mode, you must charge the battery. Beyond your chosen distance, the vehicle switches to fuel mode (see below).	**Electric mode:** All hydrogen (thus all electric), all the time For how many miles before refueling: [-- select a range --]
Fuel mode: 12345 miles per gallon	**Fuel mode:** 17283 miles per gallon	**Fuel mode:** 17283 miles per gallon	**Fuel mode:** 17283 miles per kilogram One kilogram of hydrogen is roughly equivalent to one gallon of gasoline.
Fueling: 5 to 10 minutes to fill tank at a service station	**Fueling:** 5 to 10 minutes to fill tank at a service station	**Fueling:** 5 to 10 minutes to fill tank at a service station **Charging:** Please indicate electric mode and range above before charging information can be shown.	**Fueling:** 5 to 15 minutes to fill tank at a service station. Longer driving range options (offered below) will take a little longer. At first, there will only be a few places you can refuel with hydrogen. Imagine there is one hydrogen station that you can use to accomplish your day-to-day local travel. It is not the most convenient location -- it requires you to go a little bit out of your way. Out-of-town trips may or may not be possible. Imagine that for at least a couple years, there will be some out of town trips you can't make in your hydrogen fuel cell vehicle. Also, you may refuel *overnight at home* if you choose the optional home fueling appliance offered below.
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Total: $57321	**Hybrid** Price: $57321 HEV: $1890 Total: $59211	**Plug-in Hybrid** Please indicate electric mode and range above before pricing information can be shown.	**Hydrogen Fuel Cell** Please indicate a fuel cell range above before pricing information can be shown.
I choose this one	I choose this one	I choose this one	I choose this one

Second design game played only by those who designed a full-size vehicle with battery-powered all-electric operation in the first game. This version is for people who retain a full-size vehicle. Note only assist operation is offered for PHEVs and there is no option to design a BEV.

Section 4: Page 10

No Trucks with All-Electric Operation, Plus Incentives

In this game, you are offered incentives to buy a vehicle other than a conventional gasoline or hybrid vehicle. You will be able to choose some, but not all, incentives. Some financial incentives vary; you will be shown the appropriate incentive amounts as you vary the vehicle designs. There are no full size vehicles that offer all-electric operation. If you designed a full size vehicles in Game 2 and want to see the effect of incentives on electric vehicles, you will have to change to a smaller vehicle. After you have specified your vehicle design and incentives, please confirm by selecting the "I choose this one" button at the bottom.

Incentives	Description
Federal income tax credit: *Everyone* who designs their next vehicle to be an *electric, plug-in electric, or fuel cell electric vehicle* is eligible for this incentive.	Ranges from **$2,500 up to $7,500**. Apply the credit to your federal taxes in the tax year in which you buy the vehicle. If you cannot use the full credit in that year, you have two more tax years to use the entire credit. If you lease rather than buy your vehicle, you may negotiate to have the entire credit taken off the lease price.
State vehicle purchase rebate	For electric and plug-in hybrid electric vehicles, the incentive varies from **$250 to $2,500** depending on battery size. All hydrogen fuel cell vehicles are eligible for **$5,000**. You apply for the state rebate after you buy or lease your new vehicle.
Home recharge or hydrogen fueling upgrade rebate	Varies from **$500 to $2,500** to increase the speed at which a plug-in vehicle can be charged at home or to provide home fueling for a hydrogen fuel cell vehicle. This may not be applied toward Quick Charging at home—that service is only available away from home.
High Occupancy Vehicle (HOV) Lanes, also known as "diamond" or "commuter lanes."	Until January 1, 2019, drivers of qualifying vehicles may drive in High Occupancy Vehicle lanes even if they are the only person in the vehicle.
Road and Bridge Tolls	Until January 1, 2019, drivers of qualifying vehicles pay half the usual toll, but only during morning and evening commute hours and only on select roads, bridges, and lanes for which tolls are collected electronically.
Workplace charging for plug-in hybrids and electric vehicles	If you commute to a workplace that does not already provide charging for plug-in hybrid and electric vehicles, assume your workplace will provide free charging.

VB03

67%

Section 4: Page 11

*

There are no full size vehicles that offer all-electric operation. If you want to see the effect of incentives on electric vehicles, you will have to change to a smaller vehicle.

Q46

Choose one of the following answers

- I'll stay with a larger vehicle, but give up on seeing the effect of incentives on electric vehicles
- I'll switch to a smaller vehicle to see the effect of incentives on electric vehicles

Set up for third design game in which full-size vehicles with all-electric operation are still not allowed, however incentives are offered for plug-in hybrids, electric, and fuel cell vehicles. Respondents who stayed with a full-size vehicle in Game 2 are told that to see the full range of incentives, they would have to switch to a smaller vehicle (offering battery-powered all-electric operation).

* **Which of the following best describes the body type of this vehicle you will likely buy?**

body3

Choose one of the following answers

- Compact car
- Mid-size car
- Large car
- Compact Truck
- Compact Van or Minivan
- Compact SUV
- I don't know

We'd like to use a specific make and model for your vehicle design game. Please select a make and model that best represents a likely next new vehicle for your household.

car3

POWERED BY edmunds.com

Make

Model

Start Over | Enter Manually

About how much do you think your household would have to spend to buy a new ? Round off to the nearest $500.

msrp3

Only numbers may be entered in these fields.

$ xxx,x00

☐ I really don't know how much we will spend

*

What do you think will be the approximate fuel economy (Miles Per Gallon – mpg) of this vehicle?

mpg3

Choose one of the following answers

- ○ 20 MPG (about average for all new trucks)
- ○ 27 MPG (about average for all new cars)
- ○ mpg (about average for a 2014)
- ○ Our next vehicle will run on electricity or hydrogen

Section 4: Page 12

No Trucks, Plus Incentives

As you explore, you can see the effect of different possibilities on the total purchase price at the bottom of each column. When you've designed a vehicle that matches your wishes and your budget, confirm your selection by checking the box at the bottom in the column of the vehicle you want.

Game3

Gasoline	Hybrid	Plug-in Hybrid	Electric	Hydrogen Fuel Cell
	Electric mode: None; fuel mode only. Some hybrids will drive short distances using only electricity, but as a practical matter not far enough to complete trips without using gasoline.	**Electric mode:** Pick both A) type of electric mode and B) distance electric mode lasts. A. Type of electric mode *Assist:* combination of gasoline and electricity provides energy use that is equivalent to 40 miles per gallon of gasoline, or 40 MPGe *All electric:* no gasoline -- select a mode -- B. Electric mode lasts for: -- select a range -- To stay in electric mode, you must charge the battery. Beyond your chosen distance, the vehicle switches to fuel mode (see below).	**Electric mode:** All electric, all the time. For how many miles before charging: -- select a range --	**Electric mode:** All hydrogen (thus all electric), all the time For how many miles before refueling: -- select a range --
Fuel mode: 12345 miles per gallon	**Fuel mode:** 17283 miles per gallon	**Fuel mode:** 17283 miles per gallon	**Fuel mode:** None; uses electricity only.	**Fuel mode:** 17283 miles per kilogram One kilogram of hydrogen is roughly equivalent to one gallon of gasoline.
Fueling: 5 to 10 minutes to fill tank at a service station	**Fueling:** 5 to 10 minutes to fill tank at a service station	**Fueling:** 5 to 10 minutes to fill tank at a service station **Charging:** Please indicate electric mode and range above before charging information can be shown.	**Charging:** Please indicate electric range above before charging information can be shown.	**Fueling:** 5 to 15 minutes to fill tank at a service station. Longer driving range options (offered below) will take a little longer. At first, there will only be a few places you can refuel with hydrogen. Imagine there is one hydrogen station that you can use to accomplish your day-to-day local travel. It is not the most convenient location -- it requires you to go a little bit out of your way. Out-of-town trips may or may not be possible. Imagine that for at least a couple years, there will be some out of town trips you can't make in your hydrogen fuel cell vehicle. Also, you may refuel *overnight at home* if you choose the optional home fueling appliance offered below.

All notes regarding options and placeholders from the first design game apply here.

				gallon of gasoline.
Fueling: 5 to 10 minutes to fill tank at a service station	**Fueling:** 5 to 10 minutes to fill tank at a service station	**Fueling:** 5 to 10 minutes to fill tank at a service station **Charging:** Please indicate electric mode and range above before charging information can be shown.	**Charging:** Please indicate electric range above before charging information can be shown.	**Fueling:** 5 to 15 minutes to fill tank at a service station. Longer driving range options (offered below) will take a little longer. At first, there will only be a few places you can refuel with hydrogen. Imagine there is one hydrogen station that you can use to accomplish your day-to-day local travel. It is not the most convenient location -- it requires you to go a little bit out of your way. Out-of-town trips may or may not be possible. Imagine that for at least a couple years, there will be some out of town trips you can't make in your hydrogen fuel cell vehicle. Also, you may refuel *overnight at home* if you choose the optional home fueling appliance offered below.
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I choose this one	I choose this one	I choose this one	I choose this one	I choose this one

Itemized price list for plug-in hybrid, electric, and fuel cell vehicles includes the incentive options. All respondents who design a qualifying vehicle receive the "federal tax credit" and their choice of one additional incentive. The effect of incentives is shown in the bottom line price as well as any non-financial incentive they selected. Incentives are shown in Table 3 of the main text.

75%

Section 4: Page 15

No Trucks, Plus Incentives

As you explore, you can see the effect of different possibilities on the total purchase price at the bottom of each column. When you've designed a vehicle that matches your wishes and your budget, confirm your selection by checking the box at the bottom in the column of the vehicle you want.

Game3c

Gasoline	Hybrid	Plug-in Hybrid	Hydrogen Fuel Cell
	Electric mode: None; fuel mode only. Some hybrids will drive short distances using only electricity, but as a practical matter not far enough to complete trips without using gasoline.	**Electric mode:** Pick both A) type of electric mode and B) distance electric mode lasts. A. Type of electric mode *Assist:* combination of gasoline and electricity provides energy use that is equivalent to 40 miles per gallon of gasoline, or 40 MPGe *All electric:* no gasoline [Assist] B. Electric mode lasts for: [-- select a range --] To stay in electric mode, you must charge the battery. Beyond your chosen distance, the vehicle switches to fuel mode (see below).	**Electric mode:** All hydrogen (thus all electric), all the time For how many miles before refueling: [-- select a range --]
Fuel mode: 12345 miles per gallon	**Fuel mode:** 17283 miles per gallon	**Fuel mode:** 17283 miles per gallon	**Fuel mode:** 17283 miles per kilogram One kilogram of hydrogen is roughly equivalent to one gallon of gasoline.
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I choose this one	I choose this one	I choose this one	I choose this one

Section 4, pp. 13-14 are not included as they are appear identical to S.4, p. 12. Different results from Game 2 send respondents to pp. 12, 13, or 14.

If respondent retains a full-size vehicle, only assist mode is offered for plug-in hybrids and there is no option to design a battery electric vehicle.

Incentives shown as part of itemized price list for plug-in hybrids and fuel cell vehicles. All other notes from the other games apply.

Section 5: Following Up On Your Vehicle Design

In at least one game, you designed your next new vehicle to be a plug-in hybrid, electric, or hydrogen fuel cell vehicle. What were your reasons for designing such a vehicle? Below are reasons some people give—feel free to add one of your own. Assign from zero to five points to a reason—more points means it was more important to you. You can assign up to 30 points; you don't have to spend all 30 points.

Q49a

Completed only by those who design a PHEV, BEV, or FCEV.

0	TOTAL
0	I'm interested in the new technology
0	It will be fun to drive
0	It will be safer than gasoline or diesel vehicles
0	To save money on gasoline or diesel fuel
0	It will be more comfortable
0	I like how it looks
0	I think it makes the right impression for family, friends, and others
0	It fits my lifestyle/activities
0	I'll save on the cost of vehicle purchase
0	I'll save on the cost of maintenance and upkeep
0	It will reduce the effect on climate change of my driving
0	It will reduce the amount of oil that is imported to the United States
0	I'll pay less money to oil companies or foreign oil producing nations
0	It will reduce the effect on air quality of my driving
0	Charging the vehicle at home will be a convenience
0	The incentives made it too attractive to pass up
0	Another motivation, please specify

*

As you designed your next new vehicle, did you think about how much gasoline, electricity, or hydrogen would cost you?

Q50a

Choose one of the following answers

- Yes
- No

Section 5: Page 2

What were your reasons for not designing a plug-in hybrid vehicle, electric vehicle, or fuel cell? Below are reasons some people give—feel free to add one of your own. Assign from zero to five points to a reason—more points means it was more important to you. You can assign up to 30 points; you don't have to spend all 30 points.

Q49b

Completed only by those who design an ICEV or HEV.

0	TOTAL
0	I'm unfamiliar with the vehicle technologies
0	Concern about unreliable electricity, e.g. blackouts and overall supply
0	Concern about vehicle safety
0	I can't charge vehicle with electricity or fuel one with natural gas at home
0	Limited number of places to charge or fuel away from home
0	I don't like how they look
0	I don't think they make the right impression
0	Cost of vehicle purchase
0	Cost of maintenance and upkeep
0	Cost to charge or fuel
0	Doesn't fit my lifestyle/ activities
0	Concern about time needed to charge or fuel vehicle
0	Distance on a battery charge or tank of natural gas is too limited
0	Concern about safety of electricity or natural gas
0	Environmental concerns
0	Concerns about batteries
0	I'm waiting for technology to become more reliable
0	I was tempted; higher incentives would have convinced me.
0	Another motivation, please specify

Section 5: Page 2

*** Did you think about how much gasoline, electricity, or hydrogen would cost you?** Q50b

Choose one of the following answers

- ○ Yes
- ○ No

81%

Section 5: Page 3

*

How much do you agree or disagree with each of these statements.

Please click the slider at the far right and move it to the point on the line that matches your answer along the scale of Strongly Disagree to Strongly Agree.

Q51

There is an urgent national need to replace gasoline and diesel for our cars and trucks with other sources of energy

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

If government would not interfere, the market would provide all the incentive required for automobile makers to sell cars and trucks that get their energy from electricity and hydrogen.

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

How much do you agree or disagree with each of the following statements.

Please click the slider at the far right and move it to the point on the line that matches your answer along the scale of Strongly Disagree to Strongly Agree.

Q54

Air pollution can be reduced if individuals make changes in their lifestyle

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

I personally worry about air pollution

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

Air pollution is a health threat in my region

Strongly Disagree | Strongly Agree | I'm unsure | **No answer**

Section 5: Page 5

How certain are you there is solid evidence that the average temperature on Earth has been getting warmer over the past several decades?

Q56

Very certain there is no solid evidence | Very certain there is solid evidence | I'm unsure | No answer

Do you believe that the Earth is getting warmer mostly because of natural processes or human activity?

Q56A

Natural Processes | Human Activity | I'm unsure | No answer

Only asked if response to previous question was on the "Very certain there is solid evidence " half of the scale.

*** Which one of the following statements about human-causes of climate change comes closest to your opinion?** Q58

Choose one of the following answers

- Human-caused climate change has been established to be a serious problem and immediate action is necessary.
- We don't know enough about climate change or whether humans are causing it; more research is necessary before we decide whether we need to take action and which actions to take.
- Concerns about human caused climate change are unjustified, thus no actions are required to address it.

*

Climate change can be reduced if individuals make changes in their lifestyle.

Q59

Strongly Disagree | Strongly Agree | I'm unsure | No answer

Not asked if answer to previous question is, "Concerns about climate change are unjustified…"

87%

Section 6: Your Household

These final few questions are important to assure that the survey respondents look like the population of your state.

* Do you own or rent your primary residence? Q69

Choose one of the following answers

- Own
- Rent
- Lease
- Other:

* How would you describe your home? Q70

Choose one of the following answers

- Detached house, also called a single family home
- Attached house (townhouse, duplex, triplex)
- Apartment Building
- Mobile Home

* Do you have solar panels to produce electricity at your home? Q72

Choose one of the following answers

- No
- Yes

* How many people are in your household? Q73

Choose one of the following answers

Please choose...

Please provide a brief description of your household. Start with yourself, then any other licensed drivers, then non-drivers.

Q74

Age:	Female or Male?	Work Status:

A row is presented for each household member as determined by the answer to the prior question regarding the number of household members. Answers are provided in categories.

Age:
Under 7
7 to 18
19 to 29
30 to 39
40 to 49
50 to 59
60 to 69
70 to 79
80 or older.

Work status categories:
Employed
Family Care Giver (not employed outside home)
Student
Retired
Presently unemployed
Not applicable

91%

Section 6: Page 3

*** Is there someone in your household that your friends and extended family would describe as being *very* interested in new technology? That is to say, this person is often among the first people to buy a product specifically because it uses new technology.** Q75

Choose one of the following answers

- Yes
- Probably yes
- Probably not
- No

*** How interested are you personally in the technical details of vehicles that run on electricity or hydrogen and how they work?** Q76

Choose one of the following answers

- Very interested
- Interested
- A little interested
- Not interested

*** Is there someone else in your household who is more interested in these details than you are?** Q77

Choose one of the following answers

- Yes, there is someone more interested than I
- Probably yes
- Probably not
- No

*** What is the highest level of formal education you personally have completed?** Q78

Choose one of the following answers

- Grade 8 or less
- Some High School
- High School Graduate or GED
- Some College
- College Graduate
- Some Graduate School
- Masters, Doctorate, or Professional Degree
- Prefer not to answer

93%

Section 6: Page 4

* My household's pre-tax income for the past tax year was in the following range. Q80

Choose one of the following answers

- Less than $39,999
- $40,000 to $49,999
- $50,000 to $59,999
- $60,000 to $69,999
- $70,000 to $79,999
- $80,000 to $89,999
- $90,000 to $99,999
- $100,000 to $124,999
- $125,000 to $149,999
- $150,000 to $199,999
- Greater than $200,000
- I prefer not to answer

* Whether you are a member or not, with what political party do you most strongly identify? Q81

Choose one of the following answers

- Democratic
- Republican
- None
- Other:

97%

Section 6: Page 6

*** Thank your for taking the time to complete this questionnaire. We are very interested in talking to you about your response to this survey—whether or not you think electric or hydrogen vehicles are right for your household and the country. If you would like to speak with us further about your responses, please provide your e-mail below. We will *only* use it for the purpose of scheduling an interview with you about this questionnaire. You are *not* required to enter contact information to receive your incentive for completing this questionnaire.** Q82

Choose one of the following answers

- ○ Yes, you may contact me to schedule an interview about this survey.
- ○ No thanks, I'm done.

If you want to offer any final comments, please enter them in the box below. Q83